Vol. XXVII.—No. 188 March, 1945

THE MINERALOGICAL MAGAZINE

AND

Journal of The Mineralogical Society

(INSTITUTED FEBRUARY 3, 1876.)

WITH A SEPARATELY-PAGED APPENDIX OF

MINERALOGICAL ABSTRACTS

EDITED BY L. J. SPENCER, F.R.S.

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LONDON
HUMPHREY MILFORD, OXFORD UNIVERSITY PRESS,
AMEN HOUSE, WARWICK SQUARE, E.C. 4

1945

Price 6s. net.
Annual Subscription for four numbers, Post free, 20s.

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BULLETIN SUISSE
DE
MINÉRALOGIE ET PÉTROGRAPHIE

Published by the Mineralogical and Petrographical Society of Switzerland. Numbers are issued semi-annually and contain about 200 pages. Among the contributors are all Swiss mineralogists and petrographers and the mineralogical institutes of the Swiss Universities. The papers cover the whole field of crystallography, mineralogy, and petrography, with special reference to the Alps.

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Messrs. LEEMANN & Co., A.G., Stockerstrasse, Zürich 2.

Back numbers, so far as still available, can be procured from the publishing company.

REFRACTOMETERS

We shall be pleased to send details of the Tully, Rayner, and Anderson-Payne Refractometers to any inquirer and hope that the time will soon come when we shall be able to supply the instruments as readily as we can now supply information concerning them.

RAYNER

100 NEW BOND STREET, LONDON W. 1

PROCEEDINGS

OF THE

MINERALOGICAL SOCIETY

(1944)

EXCERPT MINUTES OF COUNCIL MEETING

Held in the Apartments of the Geological Society, Burlington House, London, W., January 27, 1944, at 2.15 p.m.

Mr. F. N. Ashcroft, President, in the Chair.

. John Jerom Hartley, Mr. Kiguma Jack Murata, and Mr. Douglas Gilbert n Whitten, were proposed and provisionally elected Ordinary Members of Society. The deaths of Major H. J. L. Beadnell and Dr. R. C. Wilson were ted.

ports were received from the Treasurer and the Editor, and the Treasurer nted the audited accounts for 1943 which were adopted. It was agreed that rs of subscriptions from Members in enemy-occupied countries which had mulated since the outbreak of war should be remitted.

e President reported that paper for the index number of the *Magazine* had ne available, and that the printer had agreed to print the Bye-laws and of Members as a separate publication.

e following committee was appointed to consider the utilization of the Miers est and to report its findings at the next meeting: the Officers of the Society, homas H. Holland, Dr. W. F. P. McLintock, and Sir Arthur Russell.

e following were appointed to serve on the committee formed in conjunc- with the Geological Society and the Royal Microscopical Society to investi- the manufacture of petrological microscopes in this country after the war: . F. Claringbull, Dr. C. E. Marshall, and Dr. F. C. Phillips. It was agreed the Mineralogical Society should take formal responsibility for convening ommittee.

GENERAL MEETING

Held in the Apartments of the Geological Society, Burlington House, London, W., January 27, 1944, at 3.30 p.m.

Mr. F. N. Ashcroft, President, in the Chair.

irty-seven Members and twenty-eight Visitors were present.

e elections of Messrs. J. J. Hartley, K. J. Murata, and D. G. A. Whitten as ary Members of the Society were confirmed.

o short lectures on Quartz, with special reference to its piezoelectric

properties and their applications, were delivered and followed by a gene discussion.

(1) Dr. W. A. Wooster: Crystallography and crystal physics of quartz. Importance of quartz in the science of crystallography and crystal physi (*b*) Development of the study of the angles between faces of quartz. (*c*) Grow forms and twinning relationships. (*d*) Optical properties, particularly of rotato polarization. (*e*) Thermal conduction. (*f*) Elasticity. (*g*) Piezo- and py electricity.

(2) Mr. J. L. Creighton: Manufacture and performance of quartz crystal un (*a*) Design requirements of oscillators and resonators. (*b*) Suitability of qua for the purpose. (*c*) Manufacture. (*d*) Performance.

EXCERPT MINUTES OF COUNCIL MEETING

Held in the Apartments of the Geological Society, Burlington House, London, W., March 23, 1944, *at* 2 *p.m.*

Mr. F. N. Ashcroft, President, in the Chair.

Mr. Alfred Heller and Mr. Theodor Martin William Strong were proposed a provisionally elected Ordinary Members of the Society. The death of Mr. J. de Castro was reported. The name of Mr. D. Balsillie was removed from the Li of Members for non-payment of arrears of subscription.

A report was received from the committee appointed at the last meeting consider the utilization of the Miers bequest. It was agreed that the legacy £200 be used as a nucleus of a fund to be called 'The Miers Memorial Fund', a that Members of the Society be invited to contribute to the fund. A draft s of rules for the administration of the fund was approved (vol. 27, p. 23).

Reports were received from the Treasurer and the Editor. It was decided print as soon as possible in the *Magazine* a biographical notice with bibliograp and portrait of the late Sir Henry A. Miers (vol. 27, pp. 17–28). The portr (plate III) would be issued as the first illustration published under the Mi Memorial Fund.

GENERAL MEETING

Held in the Apartments of the Geological Society, Burlington House, London, W., March 23, 1944, *at* 3.30 *p.m.*

Mr. F. N. Ashcroft, President, in the Chair.

Thirty-three Members and twenty-two Visitors were present.

The elections of Messrs. A. Heller and T. M. W. Strong as Ordinary Memb of the Society were confirmed.

Mr. E. P. Bottley exhibited a fine specimen of autunite from Portugal; a Dr. G. Nagelschmidt showed a series of X-ray photographs of minerals.

The following papers were read:

1. An X-ray study on the crystal-structure of gümbelite: by Dr. E. Ar (communicated by Mr. F. A. Bannister) (vol. 27, p. 11).

. On rhodonite and tephroite from Treburland manganese mine, Altarnun, nwall; and on rhodonite from other localities in Cornwall and Devonshire: Sir Arthur Russell.

. The determination of beryllium in minerals and rocks: by Mr. G. H. Osborn Dr. W. Stross.

. Notes on the sawing and cleaving of diamond: by Mr. Paul Grodzinski . 27, p. 47).

. An unusual occurrence of bedded thenardite: by Dr. Edmundson Spencer d by Dr. G. F. Claringbull) (vol. 27, p. 29).

EXCERPT MINUTES OF COUNCIL MEETING

Held in the Apartments of the Geological Society, Burlington House, London, W., June 8, 1944, *at* 2 *p.m.*

Mr. F. N. Ashcroft, President, in the Chair.

Ir. Harold Elliott, Dr. William David Evans, and Mr. Charles A. Steen were visionally elected Ordinary Members of the Society. The death of Dr. Wilbert odchild was reported.

The list of Officers and Council for 1944–5 was considered. The following were to retire: Vice-President, Dr. W. F. P. McLintock; Ordinary Members of uncil, Mr. B. W. Anderson, Dr. C. F. Davidson, Prof. W. R. Jones, and Dr. J. V. rrison. The following were nominated for election at the Anniversary Meeting November 2, 1944: as Vice-President, Prof. W. R. Jones; as Ordinary Members Council, Mr. A. B. Broughton-Edge, Dr. K. C. Dunham, Prof. W. T. Gordon, Dr. David Williams.

t was agreed that, subject to approval by the Geological Society, the meet- s in 1945 would be held on Thursdays, January 25, March 22, June 7, and vember 8.

GENERAL MEETING

Held in the Apartments of the Geological Society, Burlington House, London, W., June 8, 1944, *at* 3.30 *p.m.*

Mr. F. N. Ashcroft, President, in the Chair.

Twenty-seven Members and four Visitors were present.

The elections of Messrs. H. Elliott, W. D. Evans, and C. A. Steen as Ordinary mbers of the Society were confirmed.

The following exhibits were shown:

. Minerals from new localities in the Machakos district of Kenya, including eckite, ilmenite, quartz, kyanite, staurolite, albite, oligoclase, euxenite, undum, and corundophilite: by Dr. C. S. Hitchen.

. Lava from the recent eruption of Vesuvius, and Scottish mica: by Mr. E. N. Bromehead.

. A petrological microscope fitted with analyser and polarizer of new-type aroid: by Dr. A. F. Hallimond.

The following papers were read:

1. Banalsite, a new mineral from North Wales: by Dr. W. Campbell Sm Mr. F. A. Bannister, and Dr. M. H. Hey (vol. 27, p. 33).

2. Boracite from a boring at Aislaby, Yorkshire: by Miss E. M. Guppy (c municated and read by Dr. J. Phemister) (vol. 27, p. 51).

3. An X-ray study of the crystal-structure of antigorite: by Dr. E. A (communicated by Mr. F. A. Bannister) (vol. 27, p. 65).

EXCERPT MINUTES OF COUNCIL MEETING

Held in the Apartments of the Geological Society, Burlington House, London, W., November 2, 1944, *at* 2 *p.m.*

Mr. F. N. Ashcroft, President, in the Chair.

Mr. James Cameron, Mr. Thorold George Jones, and Lt.-Col. Josslyn V Ramsden were provisionally elected Ordinary Members of the Society. The de of Dr. Harry Berman, Dr. E. L. G. Clegg, and Mr. E. H. Davison were repor

Reports were received from the Treasurer and the Editor. The Miers Memo Fund, including the original legacy of £200, had totalled £424. 18*s.* 0*d.* Secretary read the draft of the Annual Report of Council, which was approv

Mr. C. E. N. Bromehead and Mr. F. A. Bannister were appointed auditors 1945.

GENERAL (ANNIVERSARY) MEETING

Held in the Apartments of the Geological Society, Burlington House, London, W., November 2, 1944, *at* 3.30 *p.m.*

Mr. F. N. Ashcroft, President, in the Chair.

Thirty-five Members and two Visitors were present.

Dr. A. W. Groves and Dr. G. Nagelschmidt were appointed as scrutineers the voting papers for the election of Officers and Council.

The elections of Mr. J. Cameron, Mr. T. G. Jones, and Lt.-Col. J. V. Rams were confirmed.

The General Secretary read the following:

ANNUAL REPORT OF THE COUNCIL FOR 1943–4

Membership.—Including 11 Ordinary Members resident in enemy and enemy-occu countries, the total membership on October 31 was 275 against 267 on October 31, 1943. teen new members have been elected during the year, a considerable increase over recent ye The Society has lost by death the following seven members: Major H. J. L. Beadnell, Dr. H Berman, Dr. E. L. G. Clegg, Mr. E. H. Davison, Mr. J. P. de Castro, Dr. Wilbert Goodc and Dr. R. C. Wilson. The name of one member has been removed from the list on acc of arrears in subscription. On October 31 the membership consisted of 5 Honorary Mem and 270 Ordinary Members, of whom 43 were Life Members.

Meetings.—At the four meetings held during the session 1943–4 the total attendance was members and 57 visitors. The average attendance of 46 compares most favourably with

evious years, 35 in 1942–3, and 30 in 1941–2. At three of these meetings 10 papers have read and 6 exhibits shown. The remaining meeting was devoted to two lectures on o-electric quartz', followed by a discussion. The Society has acted as convener of a nittee nominated by the Geological and Mineralogical Societies at the suggestion of Mr. ghton-Edge, to consider and recommend on the manufacture of petrological microscopes eat Britain after the war.

iblications.—Four numbers (182–185) of the *Mineralogical Magazine* have been issued dur- he year and have contained the Proceedings in 15 pages, 6 papers in 52 pages with 3 plates 3 text-figures, and 262 abstracts in 58 pages. No. 183 contained the index to volume 26 e *Magazine* and volume 8 of the Abstracts. A new edition of the Bye-laws and List of bers has also been issued. The portrait of the late Sir Henry A. Miers published in no. 185 e *Magazine*, accompanied by a biographical notice and bibliography, is the first illustra- published with the aid of the recently instituted Miers Memorial Fund.

nancial.—The accounts for the calendar year 1943, published in the March number of the *izine*, showed an excess of assets (exclusive of the stock of the *Magazine*, certain periodicals e Society's Library, and the securities allocated to the Composition Fees Account) over ities of £1912. 10*s.* 7*d.* against £1685. 3*s.* 2*d.* at the close of 1942. The value of the ities standing in the name of the Custodian Trustee on December 31, 1943, was, General rve £1560. 4*s.* 7*d.*, Composition Fees Account £1204. 14*s.* 2*d.*

e cash at Bankers, in the Post Office Savings Bank, and in hand on January 1, 1944, nted to £381. 9*s.* 3*d.* as against £295. 17*s.* 7*d.* at the beginning of 1943. On the other , there were undischarged liabilities at the close of 1943, which were then estimated at but which amounted to £118. 8*s.* 4*d.* There were no undischarged liabilities at the of 1942.

e receipts from the annual subscriptions have been well maintained, and from January 1 ctober 31, 1944, amounted to £180. 6*s.* 0*d.* in respect of annual subscriptions for 1944, 17*s.* 7*d.* as arrears, and £3. 7*s.* 1*d.* in advance for 1945. The receipts from the Society's sher for sales of the *Mineralogical Magazine* have improved somewhat. They amounted 90. 15*s.* 5*d.* against £179. 13*s.* 5*d.* in 1943.

in 1943, the expenditure on the *Magazine* has had to be restricted. The payments made 43 amounted to £215. 5*s.* 6*d.* and the liabilities in respect of the 1943 issue to £118. 8*s.* 4*d.*, ng £333. 13*s.* 10*d.* against £364. 18*s.* 4*d.* in 1942.

ro Composition Fees were received and invested.

rly in the present year the following three important decisions were taken by the Council: The commemoration of the name of Sir Henry A. Miers and his services to the Society e institution of a Fund bearing his name. The rules governing the use and administration is Fund have been published in the June number of the *Magazine*. The legacy of £200 eathed by Sir Henry Miers has been transferred to the Fund and up to October 31, 18*s.* 0*d.* had been received as donations thereto. The invested capital of the Fund now ls at £375. 0*s.* 0*d.*

The remission of all Annual Subscriptions due from Members of the Society resident in y-overrun countries, and the recommendation to future Councils that this policy should ntinued until the end of the war in Europe.

In view of the receipt of further information as to the legal position, discontinuation of cation of the Composition Fees Account, amalgamation of the securities representing osition Fees received with those of the General Reserve, and the issue of an account— termed The Composition Fees (Investment) Account—in which only the Composition received each year and the investments made therewith shall be recorded.

e cash available for current purposes on October 31 amounted to £608. 19*s.* 11*d.* as against 15*s.* 4*d.* on that date in 1943, but the account for the printing and distribution of the number of the *Magazine* and the authors' offprints from the March number, now to hand totalling £65. 10*s.* 0*d.*, had not then been received. That of the Miers Memorial Fund was 10*s.* 9*d.* The outgoings for the remainder of the year, provided it is possible to settle the nts for the September and December numbers of the *Magazine* before the close of the are estimated at about £275, but it is probable that some of these will remain as undis- ed liabilities. The receipts are estimated at about £55, and on this basis the cash available neral purposes at the close of the year should be about £389.

neral.—The arrangements referred to in recent Annual Reports relative to the trans- on of remittances from overseas have been continued with success.

[*continued on p. xxvi*

ABSTRACT OF RECEIPTS AND PAYMEN

GENERAL PU

Receipts	£	s.	d.	£	s.
By Balances brought forward from 1943—					
1. At Bankers on Current Account	138	14	0		
2. In Post Office Savings Bank	240	17	6		
3. In Office	1	17	9		
				381	9
Entrance Fees				12	12
Annual Subscriptions—					
1. Current Year	187	9	3		
2. Arrears	14	18	5		
3. Advance	13	19	6		
				216	7
Sale of Publications—					
1. By Publisher, April 1, 1943–March 31, 1944. Sales at subscription rate £216. 0*s.* 0*d.* and other sales £52. 4*s.* 6*d.* less trade discount and commission £71. 8*s.* 2*d.* and distribution charges £6. 0*s.* 11*d.*	190	15	5		
2. By Custodian of Stock, 1944, £14. 13*s.* 11*d.* less distribution charges £0. 7*s.* 8*d.*	14	6	3		
				205	1
Advertisement Fees £8. 18*s.* 3*d.* less commission £1. 15*s.* 8*d.*				7	2
Interest on Investments including Income Tax recovered—					
1. £1685 3½% War Loan, 1952 and after	58	19	6		
2. £105 4% Consolidated Loan, 1957	4	4	0		
3. £100 4% Funding Loan, 1960–90	4	0	0		
4. £146 10*s.* 0*d.* 3% War Loan 1955–59	4	7	8		
5. £26 3% Conversion Loan 1948–53	0	15	6		
6. £100 3% Defence Bonds	3	19	9*		
7. £250 3% Savings Bonds 1960–70	7	10	0		
8. Income Tax recovered on 3% Savings Bonds dividend paid less tax in 1943	1	17	2		
				85	13
Deposit Interest—					
1. Bankers	0	10	9		
2. Post Office Savings Bank	6	0	0		
				6	10
Small Receipts				0	3
Transfers from other accounts—					
From Miers Memorial Fund, for provision of Illustrations				22	2
				£937	2

* Including dividend on £200 Defence Bonds received prior to the institution of the Miers Memorial Fund and the transfer of Sir Henry Miers's legacy thereto.

SOCIETY

FOR THE YEAR ENDING DECEMBER 31, 1944

POSES ACCOUNT

Payments	£	s.	d.	£	s.	d.
o Printing and distributing the Mineralogical Magazine, Nos. 183–186 (Oxford University Press)—						
1. Printing	286	12	9			
2. Illustrations	33	12	2			
3. Authors' Separate Copies	8	10	9			
4. Distribution Charges	10	14	1			
5. Composing extra copy of cover for use with offprints	3	6	6			
6. Balance due in respect of Authors' Separate Copies from No. 182	0	1	3			
				342	17	6
Printing and distributing Bye-laws and List of Members—						
1. Printing	20	12	0			
2. Distribution Charges	0	16	5			
				21	8	5
Printing and distributing Notices of Meetings and other annual printing				15	18	9
Miscellaneous printing, &c., not annual—						
1. Treasurer's Notices	1	9	0			
2. Letter headings, &c.	2	8	5			
3. Petrological Microscope Committee, duplicating Report	3	2	0			
				6	19	5
Expenses at Meetings—						
1. Operator of Lantern	2	2	0			
2. Porter	1	0	0			
3. Tea	4	5	0			
				7	7	0
Custodian Trustee's charges				0	13	0
Care and storage of stock of Publications—						
1. Care of stock in London; J. Mugford	1	1	0			
2. Storage of stock in Oxford	1	15	0			
				2	16	0
Editor's Honorarium				50	0	0
Postage—						
1. Hon. Secretary	1	13	6			
2. Editor (not charged)	0	0	0			
3. Hon. Treasurer	1	5	0			
				2	18	6
Foreign Exchange; Control charges and losses on exchange				1	8	5
Small items including Bank Charges				1	12	8
Balances December 31, 1944—						
1. At Bankers:						
(a) On Deposit Account	110	0	0			
(b) On Current Account	126	5	0			
2. In Post Office Savings Bank	246	17	6			
3. In Office	0	0	7			
				483	3	1
				£937	2	9

amined and compared with Vouchers and found correct.

C. N. Bromehead
F. A. Bannister } Auditors.

nuary 23, 1945.

A. J. Bull, Hon. Treasurer.

MIERS MEMORIAL FUND YEA

Receipts	£	s.
By Legacy received and invested prior to the institution of the Fund and transferred thereto	200	0
Donations received during year	230	3
Interest on Investments	3	4
	£433	7

COMPOSITION FEES (INVESTMENT) ACCOU

Receipts	£	s.
By Composition Fees received during year	31	1(
	£31	1(

Note:—The total sum received to date as Composition Fees and invested was on December 31, 1944 . . . . £1254 15

BALANC

DECEMB

Liabilities	£	s.	d.	£	s.
To Annual Subscriptions received in advance—					
1. Received in 1943 for 1945	1	2	6		
2. Received in 1944 for 1945	11	17	6		
3. Received in 1944 for 1946	1	1	0		
4. Received in 1944 for 1947	1	1	0		
				15	2
Sundry Creditors—					
Oxford University Press (Printers):					
1. For No. 187 of the Mineralogical Magazine exclusive of Authors' Separate Copies	59	0	9		
2. For Authors' Separate Copies from No. 187 of the Mineralogical Magazine, estimated at	2	10	0		
3. Other items	0	2	6		
				61	13
Special Funds—					
Miers Memorial Fund				403	0
Excess of Assets over Liabilities				3010	16

NDING DECEMBER 31, 1944

Payments	£	s.	d.
Investments representing legacy; £200 3% Defence Bonds. . . .	200	0	0
Investment; purchase of £175 3% Defence Bonds	175	0	0
Preliminary expenses; printing and distributing circular letter, &c. . .	5	3	7
Printing and distributing complimentary copies of the portrait of Sir Henry Miers	3	1	0
Transferred to General Purposes Account for Illustrations	22	2	8
Balance December 31, 1944—			
At Bankers on Current Account	28	0	6
	£433	7	9

amined and compared with Vouchers and found correct.

C. N. Bromehead
F. A. Bannister } Auditors.

nuary 23, 1945.

A .J. Bull, Hon. Treasurer.

EAR ENDING DECEMBER 31, 1944

Payments	£	s.	d.
Investments; purchase of £31. 2*s.* 0*d.* 3% War Loan, 1955–59 . . .	31	10	0
	£31	10	0

amined and compared with Vouchers and found correct.

C. N. Bromehead
F. A. Bannister } Auditors.

nuary 23, 1945.

A. J. Bull, Hon. Treasurer.

HEET

1944

Assets	£	s.	d.	£	s.	d.
y Investments at Broker's Valuation—						
1. £1685 3½% War Loan, 1952 and after, at 104% . .	1752	8	0			
2. £105 4% Consolidated Loan, 1957, at 110 1/16% . . .	115	11	3			
3. £100 4% Funding Loan, 1960–90, at 113½% . . .	113	10	0			
4. £146 10*s.* 0*d.* 3% War Loan, 1955–59, at 102 3/16% . .	149	14	1			
5. £26 3% Conversion Loan, 1948–53, at 103¼%	26	16	11			
6. £100 3% Defence Bonds at par	100	0	0			
7. £250 3% Savings Bonds, 1960–70 at 100½% . . .	251	5	0			
				2509	5	3
pecial Funds (Miers Memorial Fund)—						
£375 3% Defence Bonds at par				375	0	0
undry Debtors—						
Publishers (Oxford University Press):						
1. For sales of Publications, April 1–December 31, 1944 .	75	1	3			
2. For Advertisement Fees, April 1–December 31, 1944 .	8	11	5			
				83	12	8
nnual Subscriptions in Arrear (£65. 11*s.* 7*d.* including £37. 3*s.* 7*d.* due from enemy countries) estimated to realize . .				10	10	0
ntrance Fees in Arrear				1	1	0
alances—						
General Purposes Account—						
1. At Bankers						
(*a*) On Deposit Account	110	0	0			
(*b*) On Current Account	126	5	0			
2. In Post Office Savings Bank	246	17	6			
3. In Office	0	0	7			
				483	3	1
ecial Funds (Miers Memorial Fund)						
At Bankers on current account				28	0	6
				£3490	12	6

ote:—The value of the periodicals retained after the disposal of the Library and that of the

On the proposal of Dr. K. C. Dunham, seconded by Mr. G. H. Osborn, adoption of the Annual Report was carried unanimously.

A vote of thanks to the Geological Society for the use of its apartments w proposed by Dr. C. E. Marshall, seconded by Mr. A. W. G. Kingsbury, a carried with acclamation.

A vote of thanks to the retiring Vice-President and Ordinary Members Council was proposed by Dr. C. S. Hitchen, seconded by Dr. R. S. Collins, a carried.

The scrutineers reported that 18 ballot papers had been returned and examin and that the following list as nominated by the Council had been approved a were accordingly duly elected.

President. Mr. F. N. Ashcroft, M.A., F.G.S., F.C.S.
Vice-Presidents. Sir Lewis L. Fermor, O.B.E., D.Sc., F.R.S.; Prof. W. R. Jones, I M.I.M.M., F.G.S.
Treasurer. Dr. A. J. Bull, M.Sc., Ph.D., F.G.S.
General Secretary. Dr. G. F. Claringbull, B.Sc., Ph.D., F.G.S.
Foreign Secretary. Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.Sc., LL.D., F.R.S.
Editor of the Journal. Dr. L. J. Spencer, C.B.E., M.A., Sc.D., F.R.S.

Ordinary Members of Council

C. E. N. Bromehead, B.A., F.G.S.
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Prof. W. T. Gordon, M.A., D.Sc., F.R.S F.G.S.
Dr. David Williams, M.Sc., Ph.D., M.I.M. F.G.S.

Professor C. E. Tilley exhibited specimens of bustamite and bementite fr Treburland manganese mine, Altarnun, Cornwall.

The following papers were then read:

1. An account of the Struy lead mines, Inverness-shire, and of wulfeni harmotome, and other minerals which occur there: by Sir Arthur Russell.

2. Banalsite crystals from North Wales: by Dr. W. Campbell Smith (vol. p. 63).

3. X-ray diffraction experiments on illite and bravaisite: by Dr. G. Na schmidt (vol. 27, p. 59).

4. Riebeckite from near Sultan Hamud, Kenya Colony: by Dr. W. Camp Smith.

THE MINERALOGICAL MAGAZINE

AND

JOURNAL OF
THE MINERALOGICAL SOCIETY

o. 188 March, 1945 Vol. XXVII

Banalsite crystals from Wales.

By W. Campbell Smith, M.C., T.D., M.A., Sc.D.

Keeper of Minerals, British Museum.

[Read November 2, 1944.]

Banalsite, the new orthorhombic barium-felspar, was described from coarsely crystalline but massive material found as thin bands traversing manganese ore at the Benallt mine, Rhiw, Carnarvonshire.[1] Up to the time of the reading of the paper which announced the discovery of the mineral no crystals had been found except two showing indications of faces seen in a thin section of one of the veins. The only other indications of crystal form were lines of black inclusions seen in thin section within the irregular boundaries of crystals forming the vein-material. Now I have been fortunate to find, in a specimen recently collected by Dr. A. W. Groves from no. 5 ore-body in the Benallt mine, a small cavity containing minute crystals of banalsite.

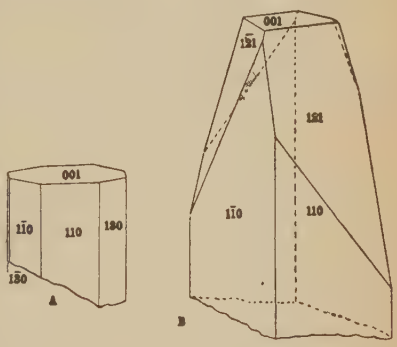


Fig. 1. Crystals of banalsite from Wales.

A. Prismatic habit. Forms (110), (130), (001).
B. Pyramidal habit. Forms (110), (121), (001).

The specimen shows a thin platy band of massive banalsite with a crust of pale-brown mica (colourless in thin flakes) carrying on its surface numerous minute, brilliant crystals of harmotome. Separated from this thin band of banalsite by a narrow slip of ore is a second mineralized band consisting of small groups of flakes of a blackish-brown chlorite partly coated with a film of baryte. It was in a shallow cavity in this band free from the baryte coating that the crystals of banalsite were found. The crystals are colourless with a pearly lustre on some faces, but the prismatic cleavage (110) shows a rather high vitreous lustre. One rather rough crystal is 2 mm. long, but the others are smaller and mostly between 0·5 and 1 mm. in length. Three of these crystals were detached from the specimen and mounted for measurement on a single-circle goniometer. The identity of the crystals as banalsite was first confirmed by means of an X-ray

[1] W. Campbell Smith, F. A. Bannister, and M. H. Hey, Min. Mag., 1944, vol. 27, pp. 33–46.

rotation photograph of one of the crystals about the *c*-axis by Mr. F. A. Bannis and compared with his previous photographs obtained from cleavage fragme

The crystal faces are dull and give no good images. By using a pin-hole sig it was found possible to obtain measurements which enabled the forms to identified by reference to angles calculated from the axial ratios deduced for t mineral from the cell dimensions.

Two habits of crystals have been observed (fig. 1): (A) prisms terminated basal plane; and (B) prisms combined with a steep pyramid and very small b plane. Two crystals of the prismatic habit were measured. The forms pres are *c*(001), *m*(110), and a second prism *t*(130). The identification of the new f is based on the following measurements:

	Average.	Limits.	Calculated.
$m(110):t(130)$	28° 24′	27° 44′–29° 5′	28° 11½′
$t(130):t'(\bar{1}30)$	42 0	41 55 –42 8	42 41
$t(130):c(001)$	90 39	—	90 0

A single crystal of the second habit measured showed the forms *m*(110) a *f*(121), both somewhat irregularly developed, terminated by small *c*(001), whi is perhaps a cleavage face. The identification of the prism faces (110) and ($1\bar{1}$ was checked from the optical orientation, and the following measurements a calculated angles establish the pyramid as *f*(121).

	Average.	Limits.	Calculated.
$m(110):f(121)$...	24° 36′	24° 34′–24° 39′	23° 49′
$m'''(1\bar{1}0):f'''(1\bar{2}1)$	23 23	22 29 –24 5	23 49
$c(001):f(121)$	75 18	75 0 –75 32	75 35
$f(121):f''(\bar{1}21)$	149 50	149 45 –149 54	151 10
$m'''(1\bar{1}0):f(121)$	100 37	—	99 46
$m'''(1\bar{1}0):f'''(\bar{1}21)$	79 11	79 1 –79 21	80 14
$f''(\bar{1}21):f'''(1\bar{2}1)$	56 57	—	58 39

The forms exhibited by the crystals of banalsite so far discovered are, therefor *c*(001), *m*(110), *t*(130), and *f*(121) referred to axial ratios $a:b:c = 0{\cdot}853:1:1{\cdot}67$ It is satisfactory to note that the form (121) is one of those identified by measur ments on the universal stage of crystal edges and of planes of inclusions seen thin sections of massive banalsite (loc. cit., pp. 34, 35).

Attempts to obtain direct measurements of refractive indices or of optic axi angle on the minute crystals were not successful, but an accurate determinati of the birefringence was made. A (110) cleavage fragment of uniform thickne was mounted on a stage-goniometer and the thickness at right angles to the cleavages was measured with a screw micrometer eyepiece. The fragment, w then transferred to the universal stage and orientated so that in turn β and were brought into coincidence with the axis of the microscope and the retardati due to, first $\gamma-\alpha$, and then $\beta-\alpha$ could be measured with the Berek compensat The values obtained in sodium-light (at 16–17° C.) are:

$\gamma-\alpha$ $0{\cdot}0082\pm0{\cdot}0002$, $\beta-\alpha$ $0{\cdot}0010\pm0{\cdot}0001$. Hence using the formu $\sin^2 V = \dfrac{\beta-\alpha}{\gamma-\alpha}$, the mean value of $2V = 40° 52′ \pm 2\frac{1}{2}°$.

The values obtained from refractive indices determined by Becke line metho (loc. cit., p. 36) agree well with these measurements.

An X-ray study of the crystal-structure of antigorite.

(With Plate V.)

By Endel Aruja, Ph.D.

King's College, Newcastle upon Tyne (University of Durham).
(Now at Adam Hilger Ltd., London, N.W.1.)

[Communicated by F. A. Bannister; read June 8, 1944.]

ANTIGORITE is a lamellar variety of serpentine, and is supposed to be a dimorphous form of chrysotile, which is finely fibrous. Its chemical composition is approximately $H_4Mg_3Si_2O_9$, which is taken as the basis of calculations re.

This study was undertaken primarily because it was hoped that knowledge of e structure of antigorite would throw some light on that of chrysotile. Certain nilarities between the two structures have been established, namely in the ·3kX or 14·6kX), and *b*(9·2kX) directions.[1] There are two main differences, wever. Firstly, imperfections which cause line broadening in the X-ray pattern chrysotile, are absent in antigorite (apart from certain 'streaks'). Secondly, e *a*(43·4kX) axis of antigorite is approximately eight times longer than the rresponding axis in chrysotile. A complete determination of the structure has t been achieved, but the X-ray pattern has been described, and some suggesns made as to the explanation of the peculiarities observed. A further study the outstanding questions is in progress.

There is some disagreement in the nomenclature of serpentines (cf. Dana,[2] lfridge,[3] Caillère[4]). This X-ray study is limited to three specimens obtained rough the courtesy of Prof. C. E. Tilley, and labelled as antigorite from: Antigorio valley, Piedmont;[5] (2) Griffin range, Hokitika, New Zealand (no. 343);[6] (3) Cropp river, Mikonui, New Zealand (no. 11566). Only the last sample coarse enough to give small flakes suitable for single-crystal photographs. cept when otherwise stated, in this work 'antigorite' stands for the material from konui. Powder photographs of the three minerals are compared in section 6.

The previous X-ray work on antigorite (Winchell,[7] Gruner,[8] Selfridge, and illère, both loc. cit.) has been confined solely to the powder method for mineral ntification purposes. Gruner, however, has compared the powder patterns of tigorite and chrysotile, finding that the unit cells are comparable, and that the o structures are closely similar as regards the *c*(14·6kX) direction.

1kX = 1000 X-units, as defined by Siegbahn. $1kX = 1{\cdot}00203 \times 10^{-8}$ cm., according to up-to-date value of Avogadro's number, $6{\cdot}0228 \times 10^{-23}$ per mole. Cf. H. Lipson and P. Riley, Nature, 1943, vol. 151, p. 250, and A. J. C. Wilson, ibid., p. 562. [M.A. 9–39.]

Dana, Descriptive mineralogy, 6th edition, New York, 1892.

G. C. Selfridge, Amer. Min., 1936, vol. 21, pp. 463–503. [M.A. 6–476.]

S. Caillère, Bull. Soc. Franç. Min., 1936, vol. 59, pp. 163–326. [M.A. 6–475.]

For a description and occurrence see T. G. Bonney, Quart. Journ. Geol. Soc. London, 1908, . 64, pp. 152–170.

The specimen numbers given are those of the Department of Mineralogy and Petrology, mbridge University.

A. N. Winchell, Amer. Min., 1928, vol. 13, pp. 161–170. [M.A. 4–206.]

J. W. Gruner, Amer. Min., 1937, vol. 22, pp. 97–103. [M.A. 7–93.]

Dana, Selfridge, and Caillère quote a number of optical and chemical data antigorite. According to Mineralogical Abstracts, extensive data about antigo may be found in a monograph on serpentine minerals by Lodochnikov.[1]

1. The unit cell.

Small flakes of antigorite from Mikonui, about 0·1 mm. thick, and 1 mm. lo which showed moderately clear isogyres under a polarizing microscope, were suitable for single-crystal photographs. The adjustment of the specimens performed by X-ray methods, because there was nothing to indicate the crysta graphic directions in the specimen except that the flakes are approxima parallel to the (001) plane, and the short fibrous fragments which make up t flake are approximately parallel to the *b*(9·2kX) axis. Oscillation crystal ph graphs were taken about all three crystallographic axes. Weissenberg ph graphs were taken of the equatorial and the third layers of the *b*-axis, and Laue photographs with X-rays parallel to the *c*(7·3kX) and *a*(43·4kX) direct respectively.

Except for Laue photographs, Cu–Kα radiation, filtered through a nickel f was used in this work. The camera employed was 60·0 mm. in diameter, and h a collimator of 0·7 mm. bore, 40 mm. long.

Oscillation and Laue photographs reveal only one symmetry plane, that p pendicular to the *b*(9·2kX) axis. Rotation and oscillation photographs about t three crystallographic directions agree with a monoclinic unit cell (cf. tables I, I and III) of: *a* 43·39, *b* 9·238, *c* 7·265kX, β 91·40°.

The probable error in the determination of the axial lengths should be less tha 0·1%. Of the inter-axial angles $\alpha = 90°$ with a high accuracy (cf. table II). T angle γ (90°) is not determined with the same accuracy (cf. table I). The mon clinic symmetry, however, is revealed by the observation of a plane of symmetr

TABLE I. Antigorite from Mikonui, New Zealand. The equator of the *c*-axis rotation phot graph. Cu–Kα (filtered) radiation, camera 60 mm. in diameter. Intensities are estimat visually. A stroke / in the column of intensities indicates that the reflection is a vertic streak. The calculations are for a monoclinic unit cell *a* 43·39, *b* 9·238, *c* 7·265kX, β 91·40 $\Delta = 4\sin^2\theta_{obs.} - 4\sin^2\theta_{calc.}$

$4\sin^2\theta_{obs.}$	Intens.	*hkl.*	$\Delta \times 10^4$.	$4\sin^2\theta_{obs.}$	Intens.	*hkl.*	$\Delta \times 10^4$
0·1098	4/	020	−13	1·3634	5	17 6 0	−1
		810	+14			33 0 0	−77
0·1300	3/	910	+2	1·4534	3	34 0 0	−20
0·3530	3	930	+11	2·2648	1	40 3 0	+5
0·3633	4	17 0 0	−6	2·3650	2	41 3 0	−13
0·8056	1/	17 4 0	−26			33 6 0	−57
0·9749	10	24 3 0	−3	2·9004	3	48 0 0	−3
1·0004	8	060	+8	2·9781	4	24 9 0	+38
1·0960	1	26 3 0	−51	3·8932*	3	48 6 0	−7

* Observed a resolved Cu–Kα_1 line; for all other calculations a weighted mean wave-leng 1·53867kX, is used.

[1] V. N. Lodochnikov, Serpentine and serpentinite . . . Trans. Centr. Geol. Prosp. In Leningrad, 1936, no. 38. (Russian, with German summary.) [M.A. 7–3.] Also E. S. Simps Journ. Roy. Soc. W. Australia, 1938, vol. 24, pp. 107–122. [M.A. 7–340.] T. Du Rietz, Ge För. Förh. Stockholm, 1935, vol. 57, pp. 133–260. [M.A. 6–216.] B. P. Krotov, Mem. S Naturalists Imp. Kazan Univ., 1915, vol. 47, no. 1. [M.A. 2–170.]

ABLE II. Antigorite from Mikonui, New Zealand. The equator of the a(43·39kX) axis rotation photograph. Dots, or streaks, in the column of intensities indicate a row of spots, or orizontal streaks, respectively. Other details as for table I.

$4\sin^2\theta_{obs.}$	Intens.	hkl.	$\Delta\times10^4$.	$4\sin^2\theta_{obs.}$	Intens.	hkl.	$\Delta\times10^4$.
0·0453	8 :	001	+4	1·0456	6 .	061	+11
0·1122	8 —	020	+11	1·1218	4 :	005	+2
0·1562	4 =	021	+2	1·1790	4 :	062	−1
0·1810	8 :	002	+15	1·4044	4 :	063	+10
0·2945	2 =	022	+39	1·6160	3 :	006	+9
0·4046	4 :	003	+8	1·7204	1 :	064	+30
0·4484	2 —	040	+41	2·1268	3 :	065	+46
0·4892	4 —	041	0	2·1968	2 :	007	−15
0·6248	3 =	042	+10	2·6178	3 :	066	+29
0·7184	4 :	004	+6	2·8712	2 :	008	−1
0·8192	1 =	024	−103	3·1992	2 :	067	+13
0·8508	1 =	043	+27	3·8634*	4	068	−9
0·9984	10 .	060	−12	3·8848*	2	068	+11

* Resolved Cu–Kα doublet.

ABLE III. Antigorite from Mikonui, New Zealand. Some reflections of the a(43·39kX) axis hotograph, showing the agreement of the monoclinic angle. Details as for table I.

$4\sin^2\theta_{obs.}$	hkl.	$\Delta\times10^4$.	$4\sin^2\theta_{obs.}$	hkl.	$\Delta\times10^4$.
0·0897	710	+2	0·3524	$73\bar{1}$	−17
0·1090	810	+1	0·3728	$83\bar{1}$	+3
0·1313	910	+15	0·3935	$93\bar{1}$	0
0·1509	$81\bar{1}$	+5	0·7058	$73\bar{3}$	−19
0·1774	911	−2	0·7461	$93\bar{3}$	+7
0·3515	930	−4			

Density.—A 'molecule' of $H_4Mg_3Si_2O_9$ weighs $277\cdot1\times1\cdot650\times10^{-24}$ g. Assuming xteen such molecules in a unit cell of dimensions given above, the density lculated by X-ray methods would be 2·51 g./cm.^{3} This is 3·5% smaller than ıe observed density of antigorite, 2·60 g./cm.^{3}, obtained by flotation. The asons for this discrepancy cannot be discussed before an analysis of the specimen ed is obtainable. An isomorphous substitution by heavier atoms, for instance, ay take place, as in chrysotile, where the contents of the unit cell actually eigh 1% more than would be in accordance with the ideal composition.

2. *Special features of the X-ray pattern of antigorite.*

The notable features of the X-ray pattern of antigorite are the streaks parallel the c^* direction [an asterisk signifies the corresponding reciprocal axis], the riation of intensities of the spots in the a^* row-lines, and additional spots, on cillation photographs, and radial streaks on Laue photographs. These features ill be discussed separately.

(i) Streaks, instead of sharp reflections, parallel to the c^*-axis appear whenver the index k is not a multiple of three. These streaks are of maximum intnsity at the reciprocal plane of the index l an integer, but they extend at least lf-way between these reciprocal layers, possibly until the next integral value l. A point of unknown significance is a picturesque bicycle-chain-like formation streaks (pl. V, fig. 1): though the streaks may link up through consecutive yer-lines on the c-axis oscillation photographs, for the same h and k values there e never more than two consecutive layers thus bound with an unbroken streak.

This reveals the asymmetry of the streaks about the integer lattice point. Possibl explanations for the streaks will be discussed in section 4.

(ii) The variation of the intensities of the reflections in the a^* row-lines re sembles the phenomenon of beats in acoustics. Because of the length of th a(43·4kX) axis, the a^* row-lines are very prominent. The observed spots in ever a^* row cluster about certain h values, which are apparently a multiple of eigh including zero. This clustering is particularly evident on rotation, and on Weissen berg photographs, where not more than six spots appear in a cluster (pl. V, fig. 3). Occasionally, however, there appear on the oscillation photographs all the re flections in a row-line for every consecutive h value over a considerable rang (pl. V, fig. 2). The average distance between the centres of gravity of such clust in any row is sixteen, in units of the index h. Incidentally, the centre reflectio itself at $h = n \times 8$ of such clusters may be occasionally of zero intensity. For instance, the $h02$ row (the fourth reflection from the centre, of fig. 3), where th reflection 002 is obviously missing. Other peculiarities are the rows $h20$, $h40$, and $h60$, for which the only reflections observed are those with $h = 0$, 17, and $\bar{1}\bar{7}$ higher orders in h are not in the range of reflection. An interval of seventeen in the h values between the strongest spots (as distinct from the distance betwee the apparent centres of gravity of clusters) in a row-line is observed also in som other rows, notably the $h11$ and $h1\bar{1}$ rows. (An average distance of seventeen in the h values of the centres of the clusters does not agree with the observations.) This grouping of spots in the row-lines is taken to indicate the presence of a kind of superlattice (cf. section 3).

(iii) Some additional spots appear on the oscillation photographs, notably on those about the b and c axes (pl. V, figs. 1 and 2). It seems, however, that all these spots can be accounted for by assuming the specimen to consist of several small fragments, each maladjusted by a turning movement of a few degrees of arc about the common a(43·4kX) direction. This dislocation may have been brought about when splitting the flake from the hand-specimen.

(iv) Laue photographs of antigorite show no conventional Laue spots, but spotty radial streaks: one streak every 60° approximately, when taken with X-rays parallel to the c(7·3kX) axis, and more irregular when the X-rays were parallel to the a(43·4kX) axis. The smearing-out of Laue spots into radial streaks could be explained either by the presence of a cross-grating structure, or by an imperfect alinement of the fragments in the specimen.[1] An imperfect alinement of the fragments has been observed on oscillation photographs, as described in the preceding subsection. On the other hand, there is evidence of, at least partial, scattering of thin lamellae (cf. the streaks parallel to the c^* direction, subsection (i)), which should also result in a cross-grating Laue photograph. Apparently, both of these causes contribute to the smearing-out of Laue spots of antigorite.

3. The sub-unit cell.

The clustering of spots at regular intervals along the a^* rows gives reason to assume a sub-unit cell of antigorite with an a-axis eight times shorter than that measured from the identity period in the a^* row-lines. [A symbol a' will be used to indicate this shorter axis.] Exactly how these sub-unit cells of $a' = 5{\cdot}4$kX are

[1] Cf. W. L. Bragg, Nature, 1929, vol. 124, p. 125.

iled up to make a unit cell of $a = 43{\cdot}4$kX, cannot be said at present. It seems hat there exists a distortion of one kind or another which makes the space-group f the crystal as a whole somewhat different from that of the sub-unit cell.

In describing the X-ray pattern of antigorite in terms of the sub-unit cell (with , c, and β the same, but $a' = a/8 = 5{\cdot}42$kX), we regard each cluster of spots as single reflection (with a certain 'fine structure') and we obtain an index H for ıe whole cluster. A cluster with the indices Hkl is counted as a 'missing reflec- on' when there is no reflection hkl observed in the row with the index h between ıe values $8H-4$, and $8H+4$. To indicate the fact that the first index refers to cluster of spots (and not to a single reflection in terms of the large unit cell) a ıbscript $_H$ is added, where necessary.

The following are the reflections (clusters) observed in terms of the sub-unit :ll:

$00l_H$ all orders in l (observed for l up to 8)
$0k0_H$ only if k even (observed for $k = 2, 4, 6$)
$H00$ only if H even (observed for $H = 2, 4, 6$)
$H0l$ all orders in l, only if H even (observed for l up to 8, $H = 2, 4, 6$)
$Hk0$ only if $H+k$ even (observed for k up to 9, H up to 6)
Hkl all orders in l, only if $H+k$ even (observed on 229 occasions, for 113 different numerical combinations of the indices).

he probable space-groups for the sub-unit cell, consistent with the observed flections, would be $C_{2h}^3 = C2/m$, $C_2^3 = C2$, or $C_s^3 = Cm$. These are the same space- oups as found for chrysotile.

4. Comparison of antigorite with chrysotile.

Comparing the a-axis rotation photograph of antigorite with the fibre diagram chrysotile, the differences are: (i) in antigorite the a-axis is approximately eight nes longer (in chrysotile it is 5·32kX). (ii) The 'tail' of certain reflections is orter in antigorite, being one-half of that of the corresponding reflections of rysotile. (iii) The reflections $hk0$ and hkl, which are very smeared-out in rysotile, are reasonably sharp in antigorite. (iv) The $00l$'s and $h0l$'s fail to solve into Cu-Kα doublets in chrysotile, but are resolved in antigorite.

There is a strong analogy between the intensities of the reflections of the inerals, particularly the $00l$'s and $0k0$'s. These comparisons induce one to ggest that antigorite has the same sequence of atomic planes parallel to (001) chrysotile, which is built of kaolinite-like sheets with magnesium substitution, z., O_6–Si_4–$O_4(OH)_2$–Mg_6-$(OH)_6$, and repeat.[1] One such layer measures approxi- ately 7·3kX in thickness. In chrysotile the c-axis was taken 14·6kX, because of ew very weak $20l$ reflections, which may be absent in antigorite, or may be lost the background.

Out of similar layers the structures of chrysotile and antigorite have to be built

[1] Unpublished work, but an abstract, together with a photograph of the X-ray pattern of rysotile, has appeared in an article entitled 'Summarized proceedings of conference on X-ray alysis, Oxford, 1944', in Journ. Sci. Instr., 1944, vol. 21, p. 15. [M.A. 9–39.] Chrysotile m Thetford, Quebec, is monoclinic, with a 5·32, b 9·2, c 14·62kX, β 93·2°. The notation of a and c axes has been interchanged, as compared with earlier publications, to bring the posed structure into conformity with other sheet structures of silicates. Cf. also B. E. urren, Amer. Min., 1942, vol. 27, p. 235 (abstract).

up so as to explain the peculiarities of their respective X-ray patterns. It seem
that the problem can be divided into two parts: the explanation of the streal
parallel to the c^* direction, and the 'fine structure' of the clusters.

The streaks in the X-ray pattern of antigorite can be adequately explained b
assuming that from sheet to sheet (or, possibly, every second sheet) an err
occurs in the packing, viz. at random, in steps of $nb/3$, or owing to the ba
centering of the sub-unit cell, $ma'/2+nb/6$, where m and n are any integers wh

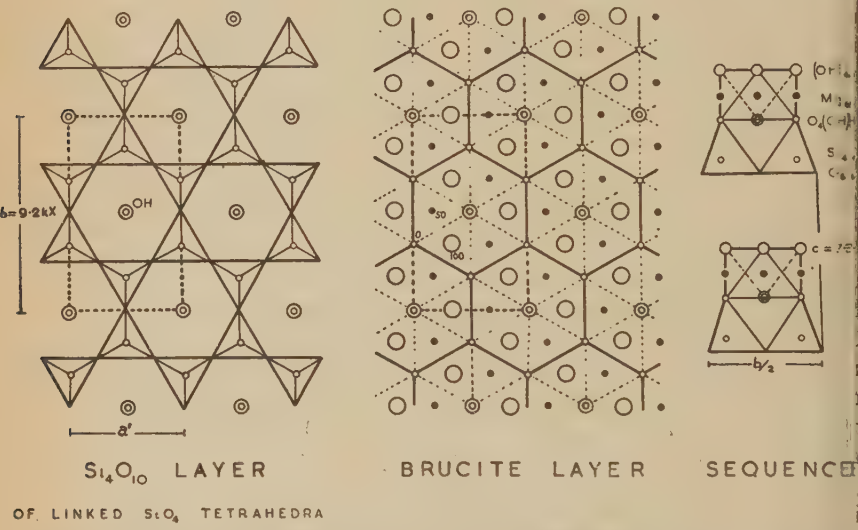


FIG. 4. Kaolinite-like sheet structure of chrysotile. LEFT: Si_4O_{10} layer obtained by he
agonal linkage of SiO_4 tetrahedra. Silicon ions in the middle of the tetrahedra are not indicate
Double circles indicate the positions of hydroxyl in the plane of oxygen ions, at the top of t
tetrahedra. MIDDLE: a projection of a brucite-like layer. Magnesium ions are situated
the octahedral cavities (black dots) between two close-packed hexagonal layers of (OH
(open large circles), and $O_4(OH)_2$ respectively. RIGHT: a schematic representation of t
sequence of atomic layers.

sum is even. Such a limited randomness ensures that the lamellae (7·3kX
possibly 14·6kX thick) scatter incoherently, except when the index k is a multip
of three (or $3H+k$ is a multiple of six). In the latter case, conventional crystalli
reflections should appear, as they actually do in antigorite. When $k \neq n\times$
(or $3H+k \neq n\times 6$), streaks perpendicular to the lamellae should, and do, appe
in the X-ray pattern. Such a limited randomness would predict that only t
reflections with $k \neq n\times 3$ are streaky, and also it determines correctly the leng
of the streaks.[1] The proneness to a slip between the sheets of antigorite is easi
understood by reference to text-fig. 4. Though the top of the 'brucite laye
and the base of SiO_4 tetrahedra contain the same number of ions per unit ce
their pattern is somewhat different, hence the instability of the fitting on top
each other of the sheets.

Unlike in chrysotile, no other distortion of the lattice (such as bending,
finite size) is required in antigorite to explain the length of the streaks or li

[1] Cf. P. P. Ewald, Proc. Physical Soc., 1940, vol. 52, pp. 167–174. [M.A. 8–133.]

roadening. However, as the streaks observed in case of antigorite are not ymmetrical about the integer lattice point, as the theory of two-dimensional ttice reflections requires (cf. Ewald, loc. cit.), such a limited randomness in the acking of layers is not a full explanation.

Another mathematical treatment of the appearance of the streaks is given by . J. C. Wilson,[1] in the case of cobalt, for powder photographs. In the type of efects of the crystals of antigorite, as described above, an error occurred in the iling up of sheets of identical structure factors. In cobalt, however, the structure ctor may vary from one unit cell to the next. Such a variation in the structure ctor is liable to happen in every structure where the unit cell has more than one ructurally equivalent set of positions. This kind of 'mistake' may also occur kaolinite-like sheets, in the choice of filling in the octahedral cavities with agnesium atoms. The octahedral cavities are formed between the close-packed yers of $O_4(OH)_2$ ions at the top of the sheet of SiO_4 tetrahedra, and $(OH)_6$ ions, ext-fig. 4. There are two equivalent positions for the $(OH)_6$ layer, with a relative isplacement of $a'/3$, consequently there are also two sets of octahedral cavities. he reflections with the index H a multiple of three would be independent of ch variations in the structure factor—a fact notably manifested in the relative arpness of the reflections of the third layer-line (a 5·3kX) of chrysotile. lthough these reflections have not been observed on the Cu-Kα photographs of ntigorite, it is likely that such a variation in the structure factor has some ntributory effect to the appearance of the streaks. As a basis for a further udy, the streaks shown on the c-axis oscillation photographs (pl. V, fig. 1) are rticularly suitable.

A diffuseness of reflections parallel to one or another of the crystallographic rections has been observed on several occasions before. Hendricks[2] reproduces number of Weissenberg photographs of micas on which streaks appear. He serves that amongst silicates such random layer structures which cause the reaks are more likely to appear when all the octahedral cavities are filled, at is, when the sheet is of higher symmetry. This is the case with magnesium icates, of which antigorite and chrysotile are examples. In these silicates, how-er, according to Pauling[3] the sheets should be curved, because of the difference the fundamental periodicity of Si_2O_5 and brucite $Mg(OH)_2$ sheets respectively.[4] chrysotile the sheets seem to be curved to such an extent that the mineral is rous, and its X-ray pattern shows extensive line broadening. In antigorite no formation of this kind is required to explain the X-ray pattern, except, perhaps, e slight asymmetry of the streaks. The expected stresses in the crystals of tigorite may have been avoided by crystallizing in a slightly different structure, ing to different geological conditions on its formation, as compared with rysotile. For instance, although it seems that chrysotile and antigorite have e same sequence of atomic planes parallel to the (001) plane, antigorite may ve a chain structure, as compared with a sheet structure proposed for chrysotile.

[1] A. J. C. Wilson, Proc. Roy. Soc., Ser. A, 1942, vol. 180, pp. 277–285. [M.A. 8–362.]
[2] S. B. Hendricks, Amer. Min., 1939, vol. 24, pp. 729–771. [M.A. 7–496.]
[3] L. Pauling, Proc. Nat. Acad. Sci., 1930, vol. 16, pp. 578–582. [M.A. 4–465.]
[4] The corresponding identity periods in the sheets of Si_2O_5 and $Mg(OH)_2$ are in the ratio of to 17, a fact which seems to be of some importance in view of the observed distances between centres of gravity of the clusters, and between the strongest spots in certain a^* row-lines, ich were also 16 and 17 units in the index h respectively (cf. section 2 (ii)).

This assumption is supported by two considerations. Firstly, though the identi periods in silicates vary between 8·9 and 9·5kX, or twice this, for one axis, a between 5·1 and 5·5kX for the other, the axial ratio remains fairly constant f the same type of linking of the SiO_4 tetrahedra. This ratio is between 1·694 a 1·703 for the chain structures (tremolite, anthophyllite, diopside, hypersthe and between 1·732 and 1·738 for the sheet structures (muscovite, phlogop pyrophyllite, talc, kaolinite, nacrite, dickite, cronstedtite). For ideal hexago structures the ratio of orthohexagonal axes is 1·732. For antigorite this rati 1·703 (in terms of the sub-unit cell), which places it amongst the chain structur whereas chrysotile with its axial ratio of 1·729 comes near to the group of sh structures.

Secondly, as Hendricks (loc. cit.) has shown, there exists a certain polyn phism in the sheet structures when the sheets are highly symmetrical and u distorted. This leads to a large unit cell in the direction perpendicular to t sheet. In antigorite, however, the lengthened a-axis lies in the plane of the sh thus, such a polymorphism could be pictured more easily on a model of cha structure, the chains running parallel to the a-axis. [If this is the case, t apparent fibrousness parallel to b(9·2kX) (cf. section 1) would be only a 'fal fibre effect', produced by the cutting of microfolded true fibres approximat parallel to the true fibres (cf. Selfridge, loc. cit.).]

Although it is possible that the cause of the observed lengthening of the a-a of antigorite is a distortion of a different kind, the possibility of a chain structu cannot be overlooked. (Cf. also a description of chrysotile as an amphibole, Warren and Bragg.[1]) It is hoped to discuss this question of distortions in t structure of antigorite at a later date.

5. *Heat-treated antigorite.*

The reports of previous workers on the decomposition of antigorite on heati are somewhat at variance. Based on X-ray evidence, some authors report th antigorite decomposes into forsterite Mg_2SiO_4 and enstatite $MgSiO_3$ (cf. Caillè loc. cit.); others have found only forsterite (cf. Gruner).[2] In the present stud only the reflections corresponding to forsterite, and no trace of enstatite, ha been found on powder photographs of antigorite from Mikonui, heated for 20 hou at 750° C. [Chrysotile from Thetford, Quebec, however, heated for 25 hours 1000° C. shows a very weak line corresponding to the strongest Debye line enstatite.]

Some oscillation and Laue photographs of antigorite were also taken, aft heating the specimen in air up to 1300° C. A complete indexing of the spots h not yet been attempted in the case of antigorite, but the pattern seems to similar to that of heated chrysotile. The main features are that the X-ray patte of antigorite changes into that of forsterite gradually, without becoming diffu at any stage of the process. Those reflections which are streaky in the patte of unheated antigorite do not become more distinct after heat-treatment, b are the last of all the spots of the old pattern to disappear. This proves that t cause of the streaks is a distortion not of the kind which can be relieved b

[1] B. E. Warren and W. L. Bragg, Zeits. Krist., 1930, vol. 76, pp. 201–210. [M.A. 4–46
[2] J. W. Gruner, Amer. Min., 1939, vol. 24, p. 186.

nnealing, e.g., not a mechanical strain. The persistence of the reflections with ıe index *l* zero shows that the linkage of the atoms is strongest in the *ab* plane. he reflections of the new pattern (forsterite), which are elongated along the ebye lines, indicate that the crystallites of the decomposition product are alined ith more than one of their crystallographic directions parallel to a given axis.

No new Debye lines appear on photographs of antigorite heated at 1300° C. for 7 hours, as compared with the same length of heating at 760° C. At higher mperatures, however, the last remnants of the pattern of antigorite have dis-ppeared, and a small change in the relative intensities of the spots on the existing ebye lines takes place. This, presumably, indicates that no structural change, ıt rather a re-orientation of the existing crystallites, takes place at higher mperatures. It is possible that the same stage of decomposition, and orienta-ɔn, could be obtained at somewhat lower temperatures by prolonged heat-eatment.

A Laue photograph of antigorite heated for 17 hours at 760° C. shows radial reaks only, which are more numerous, and without any spots on them, as mpared with a photograph taken of the same flake in the same orientation fore the heating. This was to be expected, considering the increased randomness the orientation of crystallites in the specimen, as already shown on the oscilla-ɔn photographs of the same specimen.

In conclusion. it seems, on the X-ray evidence, that serpentine minerals of mposition $H_4Mg_3Si_2O_9$ decompose on heating either into a mixture of forsterite d enstatite (Caillère, loc. cit.), or forsterite alone. For the latter case, Prof. C. E. lley suggested the following reaction: $2H_4Mg_3Si_2O_9 \rightarrow 3Mg_2SiO_4 + SiO_2 + 4H_2O$. ıe presence of fused silica is in a good agreement with the observed refractive lex 1·610 of the decomposition product of chrysotile, at least. [A note on the at-treatment of chrysotile will be published elsewhere.] The question whether e experimental conditions during the heat-treatment of serpentine minerals ve any influence on the results of decomposition has not yet been examined.

6. A comparison of powder photographs of antigorites from different localities.

Antigorite from Antigorio valley had the finest grain of the three specimens, d splinters of it gave fairly uniformly blackened powder lines. Antigorite from ɔkitika was coarser, but splinters of it were still not good enough for single-ystal work. It seemed, though, that in the specimens investigated the *a*- and xes were orientated entirely at random, while the *b*-axis seemed to lie within one of semi-angle less than 15°.

Powder photographs of the three minerals (including antigorite from Mikonui) comparable in their general features, though discrepancies exist. Antigorite m Antigorio valley exhibits resolved Debye lines in some places, where the ıer antigorites show broad bands only. Those bands may be due either to the ormation produced in powdering the specimens, or else the *a*-axis in the anti-ite from Antigorio valley is a submultiple of that found in the material from konui.

Conclusions.

Antigorite from Cropp river, Mikonui, New Zealand, has been examined by turning crystal, powder, and Laue methods. The unit cell is monoclinic with

a 43·4, b 9·24, and c 7·26kX, and β 91·4°. There are two notable features on t oscillation photograph of antigorite: (1) The appearance of streaks, which bri the layer-lines on the c-axis photographs whenever the index k is not a mult of three. (2) In the a^* row-lines the spots of any intensity cluster about certa values of the index h. Regarding the clusters of spots in the a^* row-lines single reflections in terms of a sub-unit cell, with the constants b, c, and β above, but the a-axis eight times shorter, the X-ray pattern of antigorite can compared with that of chrysotile. This sub-unit cell has a space-group $C_{2h}^3 = C2/$ and it is tentatively suggested that antigorite has the same structure as chryso namely, a polar arrangement of kaolinite-like sheets of atomic layers of the follo ing sequence: O_6–Si_4–$O_4(OH)_2$–Mg_6–$(OH)_6$ parallel to the (001) plane. A stricted randomness in the packing of these sheets (7·3kX thick), such as in s of $ma'/2+nb/6$ where $a' = a/8$, and m and n are any pair of integers (inclu zero) whose sum is even, would explain the appearance, and the length, of t observed streaks. A better explanation for the intensity distribution in the stre is, however, required to account for the asymmetry with respect to the int lattice points. A distortion of a different kind would be responsible for t observed lengthening of the a-axis.

The density calculated from X-ray data is 2·51 g./cm.^{3}, as compared wi 2·60 g./cm.^{3} obtained by flotation. Powder photographs prove that on heati antigorite decomposes into forsterite (and, perhaps, fused silica); no trac enstatite was found.

Acknowledgements.

The experimental part of this work was carried out in the Cavendish Labo tory, Cambridge, while holding a Scholarship from the British Council. T writer wishes to express his gratitude to Professor Sir Lawrence Bragg for l supervision of the study, and to Dr. A. J. Bradley and Dr. H. Lipson for t interest they took in the work. Professor C. E. Tilley and Dr. W. H. Tay greatly helped with discussions.

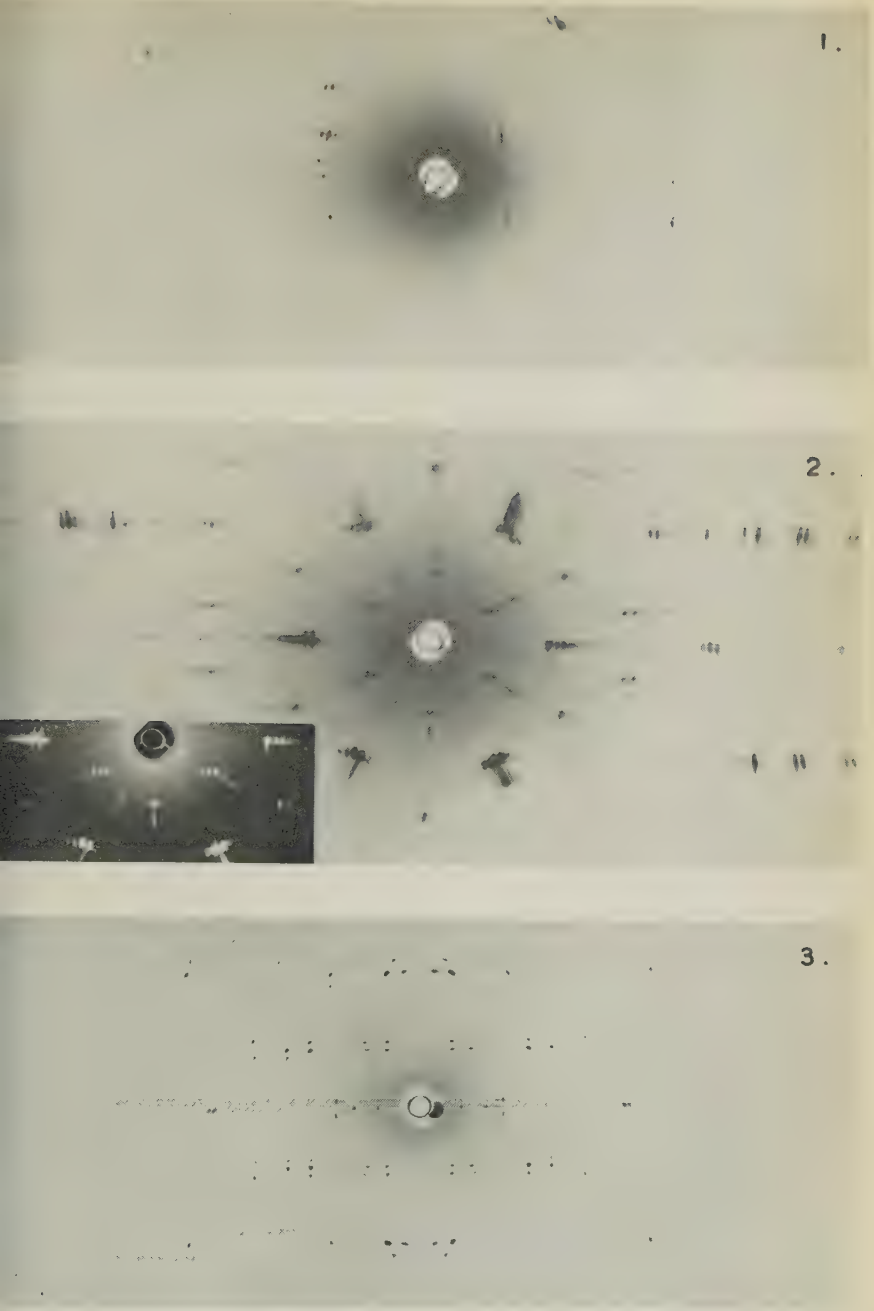
EXPLANATION OF PLATE V.

X-ray photographs of antigorite from Mikonui, New Zealand, taken in a cylindrical cam of 60·0 mm. diameter, using filtered Cu–Kα radiation.

FIG. 1. c(7·3kX) axis oscillation photograph, X-ray beam oscillating in a sector 15–30° fr the b(9·2kX) axis.

FIG. 2. b(9·2kX) axis oscillation photograph, X-ray beam oscillating in a sector $-2·5°$ $+2·5°$ from the a(43·4kX) axis. A negative of the central part of the film (slightly reduc is also reproduced, to bring out the $h10$ spots at small h values, on the first layer-line.

FIG. 3. a(43·4kX) axis rotation photograph. A maladjustment of the specimen by 0·7 the ac plane causes the distortion of the layer-lines, observed at some distance from t centre of the film.



E. Aruja: X-ray Photographs of Antigorite

MINERALOGICAL ABSTRACTS

(Vol. 9, No. 5, March, 1945.)

Notices of Books

ALACHE (Charles), BERMAN (Harry) [1902–1944], & FRONDEL (Clifford). *The system of mineralogy by James Dwight Dana and Edward Salisbury Dana, Yale University 1837–1892. Vol. 1, Elements, sulfides, sulfosalts, oxides.* 7th edition entirely rewritten and greatly enlarged, New York (John Wiley & Sons) and London (Chapman & Hall), 1944, xiii + 834 pp., 17 + [366] figs. Price $10.00 or £3.

During the 55 years up to 1892 this indispensable book of reference—the ineralogist's 'bible' the world over—passed through six editions, with several b-editions, reprints, and appendices up to 1915. Now, after a lapse of 55 years, e long-awaited seventh edition has at last appeared, this time from Harvard niversity. Since the second edition in 1844 it has been published by the firm of iley. Preparation for the new edition was commenced in 1920 at Yale Uni-rsity with the late W. E. Ford as editor-in-chief, and many colleagues have llaborated in the colossal task of collecting, selecting, and correlating the flood new data. In order to clear up many doubtful points and to fill in gaps, tensive research has been undertaken in the Harvard laboratories, which has sulted in a long series of valuable papers, while many unpublished details are w given in the book. A new classification is based on crystal chemistry as ucidated by X-rays, the classes in this volume being: (1) native elements,) sulphides, (3) sulphosalts, (4) simple oxides, (5) oxides containing U, Th, Zr,) hydroxides, (7) multiple oxides, (8) multiple oxides containing Nb, Ta, Ti e. niobates, tantalates, and titanates]. These are subdivided into types: e.g. in ass 7 as compounds ABX_2, AB_2X_4, AB_4X_7, ABX_3, A_2BX_5, AB_2X_5, AB_3X_7. osely related minerals are treated together under series, while chemical varieties e listed under an adjectival prefix: e.g. hatchettolite, uranopyrochlore, and sworthite appear as synonyms of the varietal term 'uranian pyrochlore'; and ibergite, &c., as 'argentian tetrahedrite'. Elaborate tables are given of crystal-ms and the angles of two-circle goniometry, with in addition angles to the axial nes, so that by simple subtraction many interfacial angles can be deduced. ray data are briefly given as the cell dimensions and contents and the space-oup. References to the literature are abundant, often with explanatory anno-ions. An introduction occupies 85 pages, and the remainder is descriptive neralogy. The work has been well done with very good results, and the high ndard of 'Dana' is fully maintained. Misprints are scarce. The volume is of her smaller format ($23\frac{1}{2} \times 15$ cm. and 4 cm. thick) than the last edition. It is y clearly printed on good paper and well bound. But the headings for less portant and doubtful species are overshadowed by the more prominent type d for sub-headings (cryst., phys., chem., &c.). The tragic death of Dr. Berman, o was bringing the first copy of the new book to this country, mars the pleasure ts reception, and will perhaps delay the appearance of vol. 2 (halides, carbon-s, sulphates, borates, phosphates, arsenates, &c.), and vol. 3 (silica, silicates).

L. J. S.

Buerger (M. J.). *X-ray crystallography. An introduction to the investigation of crystals by their diffraction of monochromatic X-radiation.* New York (John Wiley & Sons) and London (Chapman & Hall), 1942, xxii+531 pp., 252 figs. +17 plane groups inside covers. Price \$6.50 or £1. 19*s.* 8*d.*

This volume is confined to an account of the theory and practice of determining the space-group and unit cell of a crystal, and as such is addressed not only to those proceeding to the complete determination of crystal-structures but to those engaged in systematic crystallography. The book is based upon a clear discussion of reciprocal lattice theory and projections; and it will be chiefly used for its thorough treatment of moving-film methods, now the most important and convenient of all techniques. The normal-beam and the equi-inclination Weissenberg moving-film methods are described as well as those less commonly employed due to Sauter, Schiebold, and de Jong and Bouman. Two chapters are devoted to the accurate determination of unit-cell dimensions and interaxial angles by moving-film cameras with a detailed discussion of the errors involved. The book is well produced, profusely illustrated, and provided with numerous tables and literature references invaluable to the X-ray crystallographer. F. A. B.

Wahlstrom (Ernest E.). *Optical crystallography.* New York (John Wiley & Sons) and London (Chapman & Hall), 1943, v+206 pp., 209 text-figs. Price \$3.0 or 18*s.* 7*d.*

The scope of this book is similar to that of J. W. Evans's 'The determination of minerals under the microscope' [M.A., **3**–461], but it is written to assist workers in other fields than that of mineralogy. The author has concentrated attention on the principles, and to some extent the reader is left to refer to other works for detailed accounts of their practical applications. This is particularly noticeable in the sections of the book dealing with refractive indices and extinction-angles. On the other hand, the interpretation of optic pictures is discussed in a most thorough and excellent fashion utilizing chiefly the indicatrix and ray-velocity surfaces. The book is illustrated by abundant, well-drawn diagrams which are for the most part original. W. C. S.

Winchell (Alexander N.). *The optical properties of organic compounds.* Madison (Univ. Wisconsin Press), 1943, xiii+342 pp., chart (95×67 cm.), 157 text-figs. mimeographed. Price \$5.00 or 30*s.*

Optical and crystallographic data (with figures of crystals) are given for some 1300 solid organic compounds, with references to the literature. The classification is that of Beilstein—acyclic, isocyclic, and heterocyclic compounds, and a fourth class of natural products of which the structure is not known, including carotenoids, carbohydrates, alkaloids, &c. A determinative table (pp. 245–316) list all the compounds in order of their refractive index (n, ω, or β), ranging from 1·197 for dimethylmalonic acid to 2·2528 for sulphur iodoform solvate. The large chart gives the position of more than a thousand compounds, plotting n (ω or β) against birefringence. Optically positive crystals are above and optically negative below the central zero line, along which the few isotropic compounds are located. A simple graph gives from 2V the fractions to be added to or subtracted from n to give the γ and α values. L. J. S.

EITH (C. K.), FURNESS (J. W.), & LEWIS (Cleona). *World minerals and world peace.* Washington, D.C. (The Brookings Institution), 1943, xii+253 pp., 81 figs. Price $2.50 or 15*s*.

Part I traces the growth of world mineral production and reviews the present ineral position of the nations. In spite of recent changes in the geography of orld mineral production the interdependence of the nations is likely to con-nue. There is an interesting chapter on 'new' minerals used in present-day dustry due to developments and discovery in the last twenty years. Fifteen xcellent maps show some of the outstanding facts of mineral interdependence id world trade based on figures for 1938 (listed in Appendix C). Other appendices st industrial and mineral output for 1880–1940, and world distribution of mining id refining. Part II discusses recent trends in political and economic control. art III looks to the future; the problems of 'equal access to raw materials' and ineral control in relation to peace are discussed. The collaboration of high ithorities on mineral resources with specialists in economics has produced a ery interesting treatise on this important topic. W. C. S.

New Minerals

DAMSON (Olge J.). *Eckermannit, a new alkali amphibole. Preliminary note.* Geol. För. Förh. Stockholm, 1942, vol. 64, pp. 329–334.

DAMSON (Olge Jungstedt). *The petrology of the Norra Kärr district. An occurrence of alkaline rocks in southern Sweden.* Ibid., 1944, vol. 66, pp. 113–255. 1 pl. (map), 32 text-figs. Reprints as Acad. Diss. Stockholm, 1944, and Meddel. Stockholms Högskolas Min. Inst., no. 155. 2 pp. corrections.

An alkalic rock named kaxtropite from the farm Norra Kärr near Gränna renna) on the east shore of lake Vättern, contains glistening black rods 2 mm. ng of an amphibole which on analysis by R. Mauzelius (in A. E. Törnebohm, 06) gave SiO_2 56·45, TiO_2 0·39, Al_2O_3 5·47, Fe_2O_3 9·49, FeO 1·90, MnO 0·52, O 0·67, MgO 9·43, CaO 0·35, Na_2O 11·30, K_2O 2·41, H_2O 0·33, F 2·59 = 101·30, gr. 3·16. This is richer in soda than any alkali-amphibole previously known d gives the formula $Na_4Mg_2AlFe'''(Si_4O_{11})_2(O,OH,F)_2$; or in general $W_4(XY)_4O_{11})_2(O,OH,F)_2$, extending the amphibole series of H. Berman (Amer. Min., 37, vol. 22, p. 354). This mineral, named eckermannite, also differs from other ali-amphiboles in its optical characters: α 1·636, β 1·644, γ 1·649, 2V 75°, gative, $\beta = b$, $\alpha : c = 25°$ (up to 53° in lighter portions).

The second paper gives some further details about eckermannite (pp. 194–205). e outcrop (1200×400 metres) of alkalic rocks in the Växiö granite consists inly of grennaite (eudialyte-catapleiite-nepheline-microsyenite) with en-sures of lakarpite (arfvedsonite-albite-nepheline-syenite), pulaskite, and ktropite (pectolite-eckermannite-aegirine-nepheline-syenite, including also es deficient in pectolite or nepheline). The surrounding granite has been itized for a distance of 25–100 metres, with disappearance of quartz, recrystal-tion of felspars, new formation of albite, and alteration of biotite to aegirine-ite and augite. Optical data are given of the several minerals, including the onium minerals eudialyte, catapleiite, rosenbuschite, and one not identified. eral new chemical analyses of rocks are given, and mineral analyses by

R. Mauzelius (1906) are quoted for aegirine, catapleiite, eudialyte, felspa natrolite, and pectolite. A new analysis by A. Bygdén of light blue catapleii (α and β 1·582, γ 1·600) gave SiO_2 43·14, ZrO_2 29·16, Al_2O_3 0·79, FeO 0·17, C 2·26, Na_2O 13·59, K_2O 0·14, H_2O 10·75 (diff.) = 100·00. The more comm catapleiite is brownish-red with α and β 1·585, γ 1·603. L. J. S

Mélon (J.). [*Viseite, a new mineral.*] [Ann. Soc. Géol. Belgique, 1943, vol. Bull. pp. 53–56.] Abstract in Chem. Zentralbl., 1943, vol. 114 (vol. 2 1943), p. 995.

This was found with delvauxite at Visé, Belgium, as small wart-like mass translucent, white or bluish to yellowish, H. 3–4, sp. gr. 2·2, isotropic, n 1·5 Before the blowpipe it fuses with bubbling to a white bead and colouring t flame green. Analysis gave $5Al_2O_3.5CaO.3SiO_2.3P_2O_5.25$–$30H_2O$. Water is l gradually up to a red heat. L. J. S

Grüner (John W.). *The composition and structure of minnesotaite, a common i silicate in iron formations.* Amer. Min., 1944, vol. 29, pp. 363–372.

A mineral of abundant occurrence, with quartz (chert), chalybite, magneti stilpnomelane (now found by X-rays), and greenalite, in the Mesabi and Cuyu iron ranges of Minnesota, which earlier was referred to as amphibole and later 'mineral X' [M.A. **6**–152], is now shown by X-rays to have the structure of t and it is regarded as an iron-talc. It is greenish-grey and finely fibrous or plat $H < 3$, α 1·580, γ 1·615 (for the nearly colourless variety), straight extincti with positive elongation, $Bx_a \perp$ perfect basal cleavage, 2V small. The unit c a 5·4, b 9·40, d_{001} 19·10Å. (compared with talc, a 5·26, b 9·10, d_{001} 18·58) conta $(OH)_{22}(Fe'',Mg)_{22\cdot3}Si_{30\cdot4}(Al,Fe''')_{1\cdot4}O_{74}$ (compared with talc $(OH)_{16}Mg_{24}Si_{32}O_8$ Analysis by R. B. Ellestad gave SiO_2 51·29, TiO_2 0·04, Al_2O_3 0·61, Fe_2O_3 2·4 FeO 33·66, MnO 0·12, MgO 6·26, CaO nil, Na_2O 0·08, K_2O 0·03, H_2O+ 5·4 H_2O- 0·24 = 99·87, sp.gr. 3·01. L. J. S

Artificial Minerals

Günther (Paul), Geselle (Paul), & Rebentisch (Wolfgang). *Untersuchung zum Diamantproblem.* Zeits. Anorg. Chem., 1943, vol. 250, pp. 357–3 7 figs.

The experiments of H. Moissan of suddenly cooling molten iron containi carbon were repeated under improved conditions. Graphite and coal were a subjected to a momentary pressure of 120,000 kg. per sq. cm. at 3000–3200° in specially designed apparatus. In no case was diamond produced: its prese could not be detected by X-rays. In molten iron rich in carbon above 2000° diamond is soon converted into graphite. L. J. S

Weiser (Harry B.), Milligan (W. O.), & Marshall (John M. *Jr.*). *X-r diffraction studies on precipitated cuprous and cupric sulfides.* Journ. Physi Chem., 1943, vol. 47, pp. 496–501, 3 figs.

Cu_2S and CuS precipitated from CuCl and $CuCl_2$ solutions by H_2S sh respectively the X-ray patterns of chalcosine and covelline. When precipitat together both patterns are shown, with no indication of the presence of digeni L. J. S

MITH (F. Gordon). *The alkali sulphide theory of gold deposition.* Econ. Geol., 1943, vol. 38, pp. 561–590, 2 figs.

The successful crystallization of gold, electrum, and calaverite in aqueous olutions of alkali sulphides supports the theory that the natural solutions that eposit gold contain alkali sulphides and that gold is transported as alkali ioaurite. Brilliant faceted crystals (0·5 to 1·0 mm.) of calaverite (confirmed y X-ray powder photographs) were obtained by fusing Au, Te, S, and Na_2S nd heating the product with water to 400° C. in a bomb. M. A. P.

AWLEY (J. E.), COLGROVE (G. L.), & ZURBRIGG (H. F.). *The Fe–Ni–S system. An introduction with new data on the crystallization of pyrrhotite and pentlandite.* Econ. Geol., 1943, vol. 38, pp. 335–388, 16 figs.

Fusions of artificial NiS and FeS and of powdered Fe, Ni, S, in various proporons, give pyrrhotine and pentlandite and add to the complex picture of the stem. M. A. P.

LEMM (Wilhelm) & FRATINI (Nicola). *Zur Kenntnis des Systems NiTe–$NiTe_2$.* Zeits. Anorg. Chem., 1943, vol. 251, pp. 222–232, 3 figs.

X-ray data are given for materials ranging from NiTe to $NiTe_2$, different values eing found for material of the same composition and falling into two series cording as the calculated density is below or above that determined with the yknometer. For NiTe a $3{\cdot}97_5$, c $5{\cdot}37_0$ Å., sp.gr. 8·08 (calc. 8·37). For $NiTe_2$ $3{\cdot}88_2$ c $5{\cdot}27_5$ Å., sp.gr. 7·80 (calc. 7·52), and a $3{\cdot}83_5$, c $5{\cdot}25_0$ Å., sp.gr. 7·65 alc. 7·74). [cf. hexagonal melonite.] L. J. S.

CHENCK (R.), HOFFMANN (I.), KNEPPER (W.), & VÖGLER (HERBERT). *Gleichgewichtsstudien über erzbildende Sulfide, I.* Zeits. Anorg. Chem., 1939, vol. 240, pp. 173–197, 23 figs.

CHENCK (Rudolf) & FORST (Peter von der). —— *II.* Ibid., 1939, vol. 241, pp. 145–157, 14 figs.

— —— —— *III.* Ibid., 1942, vol. 249, pp. 76–87, 13 figs.

I. The isothermal reduction in hydrogen at 400–500° C. was investigated for e following systems. Sb_2S_3–Cu_2S, indicating compounds with the ratios 3:2, 3, 5:4, 1:1 (chalcostibite), 3:5, and 1:2 or 1:3 (fahlerz). Bi_2S_3–Cu_2S, 3:1, 2:1, 1 (emplectite), and 2:3 (klaprotholite). Sb_2S_3–PbS, 1:1? (zinckenite), 4:5 lagionite), 5:7, 3:5 (heteromorphite), 2:5 (boulangerite), 1:3 (plumbostibite). $_2S_3$–PbS, 1:1 (galenobismutite), 1:3 (lillianite), and 1:6 (beegerite). Sb_2S_3–Ag_2S, 1 (miargyrite), 3:4, and 1:2. Bi_2S_3–Ag_2S, 4:3, 1:1 (matildite), and 4:5. veral of these compounds form mixed crystals.

II. System Ni–S, with compounds NiS (millerite), Ni_6S_5, and Ni_3S_2. Ni–Sb–S, SbS (ullmannite), NiSb (breithauptite), and $NiSb_2$. Ni–Bi–S, $Ni_3Bi_2S_2$ and BiS? (kallilite).

III. System Co–S, CoS (jaipurite?) and Co_3S_4 (linnaeite). Co–Sb–S, CoSbS d $Co_{15}Sb_9S_{17}$. Co–Bi–S, Bi_2S_3, Co_3S_4, CoS, and no ternary compound. NiS ms mixed crystals with CoS and with FeS. L. J. S.

[Tananaev (I. V.) & Lelchuk (Y. L.)] Тананаев (И. В.) и Лельчук (Ю. Л. О растворимости (25°) в системе $NaF–AlF_3–H_2O$ (о химическом соста криолита). Доклады Акад. Наук СССР, 1943, vol. 41, pp. 118–120, 3 fig

Tananaev (I. V.) & Lelchuk (J. L.). *Solubility (25° C) in the system $NaF–AlF_3–H_2O$ (the chemical composition of cryolite).* Compt. Rend. (Doklady) Aca Sci. URSS, 1943, vol. 41, pp. 114–116, 3 figs.

The solid phase in equilibrium with solutions of NaF and AlF_3 is usual $11NaF.4AlF_3$; only with large excess of NaF is it $3NaF.AlF_3$. Analyses Greenland cryolite gave the same ratio NaF/AlF_3 2·72–2·75, and of commercial produced cryolite 2·7–2·8. Heating curves show the monoclinic to cubic tra formation at 590°, and melting-point 1040–1050°. L. J. S.

[Belyankin (D. S.)] Beliankin (D. S.), Lapin (V. V.), & Shumilo (I. M Белянкин (Д. С.), Лапин (В. В.) и Шумило (И. М.). *New data on t optics and chemistry of corundum.* Compt. Rend. (Doklady) Acad. Sci. URS 1941, vol. 30, pp. 738–741, 2 figs.

Corundum from chrome aluminium slags was found to have a low and variabl refractive index, and included thin lamellae, apparently of 'β-alumina'. Analys showed CaO 5·40, MgO 0·88, Fe_2O_3 0·02%, and it is concluded that the corundu itself must be calciferous. The true value of ω for pure corundum is 1·765, high values are due to impurities such as Fe and Cr; Cr_2O_3 may amount 2% natural ruby. M. H. H.

Wilde (W. T.) & Rees (W. J.). *The ternary system $MgO–Al_2O_3–Cr_2O_3$.* Trans Brit. Ceramic Soc., 1943, vol. 42, pp. 123–155, 17 figs.

A study of the components magnesia, alumina, and chromic oxide and the reaction products up to fusion temperatures. The system $Al_2O_3–Cr_2O_3$ show complete solid solution. Newly determined values of the lattice constants Al_2O_3 and Cr_2O_3 are a $4{\cdot}7491_5$, c $12{\cdot}964_6$, and a 4·9500, c 13·570Å. respectively The system $MgO–Al_2O_3$ possesses one compound $MgAl_2O_4$ which can take up considerable amount of Al_2O_3 but not MgO in solid solution at high temperature The system $MgO–Cr_2O_3$ possesses one compound $MgCr_2O_4$ with a 8·317Å. whi takes neither MgO nor Cr_2O_3 into solid solution. No stable compound $4MgO.Cr_2$ is found to exist. The lattice dimensions of the spinel compounds appearing the high magnesia portion of the ternary system depend solely on the ratio Cr_2O_3 to Al_2O_3. A complete series of solid solutions is formed between $MgAl_2$ and $MgCr_2O_4$, but the irregularities observed in the series are not due to t formation of ternary compounds. F. A. B.

Castell (H. C.), Dilnot (S.), & Warrington (Mary). *Reaction between solid* Nature, London, 1944, vol. 153, pp. 653–654, 1 fig.

Briquettes of powdered alumina and magnesia baked at 1150° C. gave th X-ray pattern of spinel, the yield being greater when the material was heate in vacuum. L. J. S.

Clark (L. M.), Hedley (A. G. M.), & Robinson (J. G.). *Crystalline magnesium and ferrous hydroxides.* Journ. Soc. Chem. Ind., 1944, vol. 43, pp. 208–210.

By the very slow mixing of dilute solutions of magnesium chloride and sodium r calcium hydroxide in a large volume of water containing a seed-bed of owdered crystalline brucite, crystalline spherulites of magnesium hydroxide ith grain size 60–90 μ were precipitated. Crystalline ferrous hydroxide, *a* 3·24, 4·47 Å., was also produced by a similar method, but in an atmosphere of nitro-en, using the isomorphous brucite again as a seed-bed. F. A. B.

Budnikov (P. P.) & Rivlin (I. I.)] Будников (П. П.) и Ривлин (И. И.). Получение окиси магния из доломита и использование ее для производства огнеупоров. Доклады Акад. Наук СССР, 1943, vol. 41, pp. 222–224.

Budnikov (P. P.) & Rivlin (I. I.). *Production of magnesium oxide from dolomite and its use in the manufacture of refractories.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1943, vol. 41, pp. 210–212.

Dolomite calcined at 1200° and treated with a saturated solution of NH_4Cl at rdinary temperature yielded MgO 34·1 % in the precipitate and 3·84 % in olution (with CaO 7·72 % in the precipitate as 50·56 % in solution). The pro-uct calcined at 1580° yielded a good forsterite refractory material. L. J. S.

uichard (Marcel) & Wyart (Jean). *Structure cristallographique des mélanges de carbonates de calcium et de strontium. Leur décomposition fractionnée par la chaleur.* Compt. Rend. Acad. Sci. Paris, 1943, vol. 216, pp. 844–846.

The precipitate obtained from mixed solutions 1:1 of $CaCl_2$ and $SrCl_2$ has the mposition $CaSr(CO_3)_2$, and gives X-ray data, *a* 5·05, *b* 8·40, *c* 5·83 Å., inter-ediate between those for aragonite and strontianite. With excess of $CaCl_2$ the recipitate consists of calcite and orthorhombic $CaSr(CO_3)_2$. When mixtures of aCO_3 and $SrCO_3$ are heated at 855°, $SrCO_3$ begins to decompose, but only after l the $CaCO_3$ has been decomposed; the compound $CaSr(CO_3)_2$ shows no dis-ntinuity in the heating curve. L. J. S.

oster (Wilder D.). *Boussingaultite from residue of fire in anthracite refuse bank.* Amer. Min., 1944, vol. 29, pp. 392–394.

Holes were bored to locate a fire in a waste heap in the Pennsylvania anthra-e field. At a depth of 158 feet the temperature was 370° C. Several tons of mestone dust and water were poured down the holes. On excavating the mass, lourless to pinkish crystals (1 mm.) of boussingaultite, $(NH_4)_2Mg(SO_4)_2.6H_2O$, re found filling cavities at the edge of the deposit of limestone dust. These ve α 1·471, γ 1·479. Spectroscopic analysis showed considerable Mg, Fe and l 0·*x*%, and traces of Ca and Si. L. J. S.

enzel (Heinrich) & Schulz (Hans) [†1939]. *Zur Kenntnis der Borsäuren und borsauren Alkalisalze, XI. Das System $NaBO_2$–H_2O.* Zeits. Anorg. Chem., 1943, vol. 251, pp. 167–200, 11 figs. [M.A. 8–115.]

X-ray diagrams are given for anhydrous sodium metaborate $NaBO_2$ and for the $_2O$, $2H_2O$, and $\frac{1}{2}H_2O$ hydrates. $NaBO_2.4H_2O$ has sp.gr. 1·743 and is triclinic

with $a:b:c = 0{\cdot}70343:1:0{\cdot}53698$, α 101° 9′, β 102° 7′, γ 107° 55′. $NaBO_2.2H_2$ is also triclinic with a unit cell a 5·86, b 10·51, c 6·75Å. ($a:b:c = 0{\cdot}5573:1:0{\cdot}642$ α 91·0°, β 57°, γ 91·5°. L. J. S.

Hill (W. L.), Faust (G. T.), & Reynolds (D. S.). *The binary system P_2O_5–$2CaO.P_2O_5$.* Amer. Journ. Sci., 1944, vol. 242, pp. 457–477, 542–562, 7 fig.

This sytem shows eight crystalline phases, for which optical and X-ray da are given: tetragonal(?) P_2O_5; $CaO.2P_2O_5$, melting-point 810°; $2CaO.3P_2O_5$ m.p. 774°; β-metaphosphate $CaO.P_2O_5$, m.p. 977°; α-$CaO.P_2O_5$, m.p. 984 *trömelite*, perhaps $7CaO.5P_2O_5$, forming solid solutions with the metaphospha metastable below 915°, melting incongruently at 985°, α 1·584, β 1·594, γ 1·60 2V near 90°, probably positive, for material containing 33·3 % CaO; β-py phosphate $2CaO.P_2O_5$; α-$2CaO.P_2O_5$, m.p. 1353°. Inversion point α–β metaph phate 963°, α–β pyrophosphate 1140°. Solid solutions between metaphosphat and pyrophosphates, with a greater range for the β-modifications. L. J. S.

Morey (George W.) & Ingerson (Earl). *The binary system $NaPO_3$–Na_4P_2O.* Amer. Journ. Sci., 1944, vol. 242, pp. 1–6, 1 fig.

The only compound between the meta- and pyro-phosphates is $Na_5P_2O_{10}$, wh forms a eutectic with 69 % $NaPO_3$ at 552°. Optical data are given. L. J. S.

Bykov (M. M.). *Synthesis of ammonium phosphates from ferroferriphosphate* Compt. Rend. (Doklady) Acad. Sci. URSS, 1943, vol. 40, pp. 66–69.

Large deposits of vivianite and its alteration products, kerchenite and oxy kerchenite, occur in the Crimea and in Siberia. A new compound $FeO.4Fe_2O$ $3P_2O_5.21H_2O$ of the oxykerchenite type was prepared; this when heated yielde cubic crystals of $3Fe_2O_3.2P_2O_5$. These materials when treated with $(NH_4)_2$ yielded $(NH_4)_3PO_4.3H_2O$, of value as a plant fertilizer. L. J. S.

Nagelschmidt (G.) & Nixon (H. L.). *Formation of apatite from superphospha in the soil.* Nature, London, 1944, vol. 154, pp. 428–429.

Superphosphate has been applied for nearly a hundred years to certain plo on the Rothamsted Experimental Station at Harpenden, where there had been previous heavy dressing of chalk. The residue from fragments of chalk gave t X-ray powder pattern of apatite, and partial chemical analyses showed t presence of fluorine. Fluorapatite is not available to plants. L. J. S.

Bredig (M. A.). *Phase relations in the system calcium orthosilicate-orthophosphat* Amer. Min., 1943, vol. 28, pp. 594–601, 1 fig.

Calcium orthosilicate, containing small amounts of various ions in solid solutio crystallizes above 1420° C. in two forms, α hexagonal and α' orthorhombic, is structural with the two corresponding forms of K_2SO_4. The hexagonal form h unit-cell dimensions a 5·40, c 6·996Å. containing $2[Ca_2SiO_4.0{\cdot}135Na_2$ $0{\cdot}068Fe_2O_3]$; the orthorhombic form a 5·18, b 9·52, c 6·77Å. containing $4[Ca_2SiO$ $0{\cdot}09CaK_2SiO_4]$. An equilibrium diagram is given of the system Ca_2SiO_4 $Ca_3(PO_4)_2$. Nagelschmidtite [M.A. 8–312] is a solid solution of $Ca_3(PO_4)_2$ α-Ca_2SiO_4; and rhenanite [M.A. 7–553] is identical with α-Ca_2SiO_4. F. A. B.

HUGILL (W.). *The spherulitic crystallisation of anorthite.* Trans. British Ceram. Soc., 1944, vol. 43, pp. 90–92, 4 figs.

Spherulites of anorthite up to 4 cm. diameter are formed by the attack of slags ontaining lime on fireclay and sillimanite refractories. A discussion of their mode f formation. F. A. B.

PARKER (T. W.) & NURSE (R. W.). *Merwinite in the system CaO–MgO–SiO_2.* Journ. Iron and Steel Inst., 1943, vol. 143 (no. 2 for 1943), pp. 475P–488P, 4 figs.

The merwinite field in the equilibrium diagram and the invariant points with he neighbouring fields of larnite, åkermanite, monticellite, and periclase are xed. Pure merwinite melts incongruently at 1590° C. forming $2CaO.SiO_2$ and quid. The data are discussed in relation to dolomite-silica refractories, the 'fal-ng' and hydration of blast-furnace slags, and the metamorphism of siliceous mestone. L. J. S.

CHOBER (Rolf) & THILO (Erich). *Chemische Untersuchungen von Silicaten, X Mitteil. Über den Topas $Al_2SiO_4(F,OH,O)_2$ und seine Synthese und über ein neues fluorhaltiges Aluminiumoxyd.* Ber. Deutsch. Chem. Gesell., 1940, vol. 73B, pp. 1219–1240, 2 figs. [M.A. **7**–310, 410, 411.]

Thermal hydrolysis of AlF_3 up to 600° yields $Al_7O_{10}F$, and over 800° α-Al_2O_3. Vith SiO_2 between 750° and 950° topaz is formed with liberation of SiF_4. With xcess of Al_2O_3 this may be taken up with enlargement of the lattice. Above and elow these temperatures a product resembling mullite is obtained. X-ray powder ata are tabulated for these products, and for analysed natural topaz from: Ouro Preto, Brazil; II, Spitzkopje, South-West Africa; III, Schneckenstein, axony.

	SiO_2.	Al_2O_3.	MgO.	CaO.	Na_2O.	F.	H_2O.
I.	32·39	57·39	0·22	0·17	0·17	12·26	3·65
II.	32·67	57·94	0·50	0·37	0·17	17·71	—
III.	32·24	57·54	0·08	0·19	0·12	13·49	4·99

L. J. S.

RIGORIEV (D. P.). *Synthesis and study of phlogopite.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1944, vol. 43, pp. 63–65.

The fluor-phlogopite previously prepared, using fluorite as a flux, contained ich calcium [M.A. **6**–54]. It is now obtained free from calcium by fusing at 50° C. a mixture of K_2CO_3, MgO, Al_2O_3, and SiO_2 with 25% NH_4F. An aggre-te of transparent colourless scales (up to 10 sq. mm.) and well-formed crystals o to 2 mm. across) in cavities were formed; α 1·518, γ 1·554. Analysis, SiO_2 ·71, Al_2O_3 14·39, MgO 28·62, K_2O 8·98, F 9·80 = 103·50, agrees with $F_2KMg_3[Si_3O_{10}]$. [M.A. **7**–284.] L. J. S.

INCE (A. T.). *The system albite-anorthite-sphene.* Journ. Geol. Chicago, 1943, vol. 51, pp. 1–16, 7 figs.

In the binary system albite-sphene there is a break in the liquidus curve at 5 % albite. In the system anorthite-sphene the eutectic composition is at 63 %

sphene, 37 % anorthite, and the eutectic temperature at 1301° C. An equilibrium diagram is given for the ternary system, and the petrological significance of the investigation is discussed with the aid of a tentative quaternary diagram of the system albite-anorthite-diopside-sphene. C. F. D.

Schairer (J. F.). *Some aspects of the melting and crystallization of rock-forming minerals.* Amer. Min., 1944, vol. 29, pp. 75–91, 14 figs.

Brief review of progress made from a study of artificial melts towards the understanding of the crystallization chemistry of the olivines, the pyroxenes and related minerals (pyroxenoids), and the melilites. Among recent or new data are included E. F. Osborn's work on merwinite; unpublished work by Bowen and Schairer on the system Na_2O–Al_2O_3–SiO_2 which showed no field for jadeite on the liquidus surface and no crystals of jadeite appeared at any of the temperatures studied; and preliminary results of Schairer and Osborn's study of the system CaO–MgO–FeO–SiO_2. Twelve of the 14 figures are equilibrium diagrams. W. C. S.

Proceedings of the symposium on the chemistry of cements. Stockholm (Ingeniörsvetenskapsakademien), 1939, xvi+578 pp., figs.

An international conference on the chemistry of cements met in Stockholm in 1938. The proceedings of this meeting, published in English, contain much information of mineralogical interest. Mention may be made of papers on 'Reactions between substances in the solid state with special reference to systems containing silica', by J. A. Hedvall (pp. 42–57); 'Constitution of Portland cement clinker', by R. H. Bogue (pp. 59–98); 'X-rays and cement chemistry', by W. Büssem (pp. 141–168); 'The calcium aluminate and silicate hydrates', by G. E. Bessey (pp. 178–215); 'The calcium aluminate complex salts', by F. E. Jones (pp. 231–245); and 'The mineral composition of aluminous cement', by N. Sundius (pp. 395–421). Among the artificial minerals on which optical or crystal-structure data are compiled are åkermanite, afwillite, centrallassite, crestmoreite, ettringite, foshagite, gibbsite, gehlenite, gyrolite, hillebrandite, hydrocalumite, okenite, perovskite, riversideite, wüstite, and xonotlite. Similar information is collected for many compounds yet unknown in nature. C. F. D.

Budnikov (P. P.) & Strelkov (M. I.). *On the problem of production of alite cement.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1943, vol. 40, pp. 20–21.

Pure alite, $3CaO.SiO_2$ (a major constituent of Portland cement), is difficult to prepare, because of intermediate reactions giving $2CaO.SiO_2$ and $3CaO.2SiO_2$. It was obtained by calcining $2CaO.SiO_2$ with CaO at 1450–1500° C. for a short period only. L. J. S.

White (James). *The physical chemistry of open-hearth slags.* Journ. Iron and Steel Inst., 1943, vol. 148 (no. 2 for 1943), pp. 579P–712P, 23 figs.

Information on thermal equilibrium and phase diagrams relating to the oxides (CaO, MgO, MnO, FeO, Fe_2O_3, Al_2O_3, P_2O_5, SiO_2) present in slags and to the system Fe–O are collected from the literature, and a bibliography of 216 items is added. The minerals present in acid and basic slags are noted. L. J. S.

X-rays and Crystal-structure

U (S. H.). *An improved algebraic method for the determination of crystal structure from X-ray data.* Science Record, Acad. Sinica, Chungking, 1942, vol. 1, pp. 109–110.

An improved modification of an algebraic method due to H. Ott [M.A. 3–423] and M. Avrami (1938). F. A. B.

UERGER (M. J.). *A new Fourier series technique for crystal structure determination.* Proc. Nat. Acad. Sci. U.S.A., 1942, vol. 28, pp. 281–284.

If the peak heights of the Patterson projections of two crystal-structures, entical save for the substitution of one atom by another, are subtracted, then ie difference projection shows $2(n-1)$ peaks instead of $n(n-1)$ peaks where n is ie number of atoms per unit cell. When the substitution atom occupies a mmetry centre, then the peaks of the difference projection give an undistorted cture of the atomic positions of the crystal-structure. The method may prove practical interest for the crystal-structure determination of members of a solid lution series. F. A. B.

ROSS (S. T.) & MARTIN (D. E.). *Quantitative determination of crystalline materials by X-ray diffraction.* Indust. Engin. Chem. Anal. Edit. (Amer. Chem. Soc.), 1944, vol. 16, pp. 95–98, 3 figs.

Photometer curves of powder photographs of mixtures with a given percentage sodium chloride yield relative line intensities of the components. The amount quartz in a rhyolite can be determined correct to 5 %. F. A. B.

HLECHT (William G.). *Calculation of density from X-ray data.* Amer. Min., 1944, vol. 29, pp. 108–110.

In calculating specific gravities from X-ray data the recent value of Avogadro's mber $6{\cdot}0228 \times 10^{23}$ should only be used if the unit-cell sides are measured in cm. ll dimensions are, however, usually measured on the Siegbahn scale (about 002 % low) and only lead to correctly calculated specific gravities if used with e older value of Avogadro's number $6{\cdot}0597 \times 10^{23}$. F. A. B.

JKESH (Joseph S.). *The distribution of metallic atoms in two-component glasses.* Proc. Nat. Acad. Sci. U.S.A., 1942, vol. 28, pp. 277–280, 1 fig.

By subtracting the ordinates of the intensity curve of pure silica-glass from ose of the curve for soda-silica-glass three peaks are obtained at 2·4, 3·65, and 75Å. which can be interpreted as due to sodium–oxygen, sodium–sodium, and second sodium–oxygen or second sodium–sodium distance. Similar data are tained for soda-boric oxide and potash-boric oxide glasses. F. A. B.

OKES (A. R.) & WILSON (A. J. C.). *The diffraction of X-rays by distorted crystal aggregates—I.* Proc. Physical Soc. London, 1944, vol. 56, pp. 174–181.

Broadening of the lines on X-ray powder photographs of cold-worked metals s been attributed to. (1) breaking down into 'crystallites' 10^{-5}–10^{-6} cm.;

(2) breaking down into crystals 10^{-4} cm. with different unit-cell dimensio
(3) distortion of crystals 10^{-4} cm. Various consequences of the third hypoth
are discussed. A simple relation between the 'apparent strain' and the brea
of a given *hkl* diffraction is deduced and approximate relations with the inte
stresses are worked out. F. A. B.

THIBAULT (Newman W.). *Morphological and structural crystallography and op
properties of silicon carbide (SiC). Part I: Morphological crystallography
etching figures. Part II: Structural crystallography and optical prope*
Amer. Min., 1944, vol. 29, pp. 249–278, 327–362, 18 figs.

Six modifications of α-SiC are now known, two new ones being SiC IV a
SiC VI both rhombohedral in symmetry. Cubic carborundum, formerly na
SiC IV, is now designated β-SiC. A detailed goniometric study of all the form
α-SiC (excepting SiC V) and β-SiC is described, based upon X-ray and op
work. Etching with borax at a red heat or chlorine at 1000° C. showed that t
I, IV, and VI of α-SiC are ditrigonal pyramidal, whereas types II and III
dihexagonal pyramidal. Twin forms and intergrowths between different for
are figured and described.

Rotation and Weissenberg photographs of crystals of each of the five types
α-SiC and that of β-SiC yielded the following data:

	a.	*c*.	$a_{rh.}$	α.	*N*.*	Space-grou
α-SiC I	3·073Å.	37·70Å.	$12·69_1$	13° 54½′	15	$C_{3v}^5 = R3m$
α-SiC II	3·073	$15·07_9$	—	—	6	$C_{6v}^4 = C6_3mc$
α-SiC III	3·073	10·053	—	—	4	$C_{6v}^4 = C6_3mc$
α-SiC IV	3·073	52·78	$17·68_3$	9° 58′	21	$C_{3v}^5 = R3m$
α-SiC VI	3·073	82·94	$27·70_4$	6° 21½′	33	$C_{3v}^5 = R3m$
β-SiC, cubic	4·349	—	—	—	4	$T_d^2 = F\bar{4}3m$

* N is the number of SiC per unit hexagonal cell for α-SiC.

The observed specific gravity of α-SiC type II is 3·218, compared with calculat
values of 3·217 for all the α-SiC types and 3·216 for β-SiC. All α-SiC types a
uniaxial positive, and possess the same refractive indices, but some variati
occurs within a given type: ω_{Na} 2·6467–2·6487, ϵ_{Na} 2·6889–2·6930. Dispersi
(4360–6200Å.) ω 0·0918, ε 0·1028. β-SiC is isotropic, for red light *n* 2·63. Powd
photographs are reproduced and spacing and intensity data given for all
types studied. Silicon carbide was the first known example of 'polytypism
'polytypic' minerals are coquimbite and paracoquimbite; parisite and synchys
(α-, β-, and γ-parisite) [M.A. **6**–271]; and graphite. F. A. B.

FYLKING (K. E.). *X-ray analysis of twinned MnP crystals.* Arkiv Kemi, Mi
Geol., 1943, vol. 17A, no. 7, 9 pp., 3 figs.

Powder photographs show that lamellar crystals of manganese phosphide, sp.g
5·49, are orthorhombic with *a* 5·905, *b* 5·249, *c* 3·167Å., unit-cell contents 4Mn
Individual crystals are contact twins on (101) and twin formation has been trac
to an excess of phosphorus. The space-group is $D_{2h}^{16} = Pnma$ and the structu
contains somewhat puckered chains of Mn atoms parallel to the *b*-axis and strong
puckered chains of P atoms parallel to the *c*-axis. F. A. B.

IAL (Olof). *X-ray analysis of $FeSn_2$ and Fe_3Sn.* Arkiv Kemi, Min. Geol., 1944, vol. 17B, no. 11, 5 pp., 2 figs.

The crystal-structures of $FeSn_2$ and Fe_3Sn are analogous to those of $CoSn_2$ Nial, 1938) and Ni_3Sn (Rahlfs, 1937). The tetragonal unit cell containing $4FeSn_2$ as a 6·520, c 5·312Å., and the structure is based upon the space-group $D_{4h}^{18} = I4/mcm$. The hexagonal unit cell of the second alloy, sp.gr. 8·00, contain-ıg $2Fe_3Sn$ has a 5·477, c 4·352Å., and the structure is based upon the space-:oup $D_{6h}^4 = C6/mmc$. [Min. Mag. **19**–120.] F. A. B.

UERGER (M. J.) & BUERGER (Newton W.). *Low-chalcocite and high-chalcocite.* Amer. Min., 1944, vol. 29, pp. 55–65, 4 figs.

Untwinned chalcosine from Bristol, Connecticut, has an orthorhombic unit cell ith dimensions a 11·90, b 27·28, c 13·41Å., containing $96Cu_2S$. X-ray photo-:aphs of the same specimen taken at 112° C. show that the inverted form is exagonal with unit cell dimensions a 3·89, c 6·68Å., and contents $2Cu_2S$. A mple dimensional relationship exists between the two forms and, assuming that ıe low-temperature form must have a space-group derivable from that of the gh-temperature form, the space-groups must be $C_{2v}^{16} = Ab2m$ and $D_{6h}^4 = H6/mcm$ spectively. This involves hemimorphic symmetry of low-chalcosine. F. A. B.

UNDQVIST (Dick). *The crystal structure of daubréelite.* Arkiv Kemi, Min. Geol., 1943, vol. 17B, no. 12, 4 pp., 1 fig.

Weissenberg photographs of a single crystal of the mineral and powder photo-aphs of artificial $FeCr_2S_4$, sp.gr. 3·80, confirm the work of Heide et alii [M.A. -301] showing that daubréelite possesses the spinel structure with a 9·975Å. he iron and chromium atoms are not distributed statistically over the sites of the etal atoms, but are situated in positions 8 (a) and 16 (d) of the spinel structure. F. A. B.

U (S. H.) & Ho (C. P.). *A new method of analysis of X-ray data for the determination of crystal structure—its application to iron pyrites.* Science Record, Acad. Sinica, Chungking, 1942, vol. 1, pp. 111–115, 2 figs.

Each main peak in a Patterson Fourier synthesis of X-ray diffraction data rresponds to a pair of atoms in the crystal-structure. The new method permits decision of which pair of atoms a given peak is due to. This is illustrated for rite. F. A. B.

U (S. H.). *The space-group of $NiCl_2.6NH_3$, $NiBr_2.6NH_3$, and $NiI_2.6NH_3$.* Science Record, Acad. Sinica, Chungking, 1942, vol. 1, p. 151.

Concludes that the correct space-group of the above salts is $F\bar{4}3m$. F. A. B.

YSTRÖM (Anders) & WESTGREN (A.). *X-ray analysis of antimony trifluoride.* Arkiv Kemi, Min. Geol., 1943, vol. 17B, no. 2, 7 pp., 2 figs.

Thin plates of antimony trifluoride are orthorhombic, a 7·25, b 7·49, c 4·95Å., lculated sp.gr. 4·39; unit-cell contents $4SbF_3$. The substance has a molecular

structure based on the space-group $C_{2v}^{16} = Ama$, each SbF_3 molecule constitut a pyramid with the three fluorine atoms situated at corners of an equilate triangle. F. A. B.

Hägg (Gunnar) & Hermansson (Erik). *On the crystal structure of cadmium iodi* Arkiv Kemi, Min. Geol., 1943, vol. 17B, no. 10, 4 pp.

Cadmium iodide crystallizes with the stable structure C 27 (Strukturberic 3–22) when the rate of crystallization is low. Disordered structures intermedi between C 27 and C 6 (Strukturbericht 1–163), a random layer lattice, a assumed at intermediate rates. F. A. B.

Sillén (Lars Gunnar). *X-ray studies on oxides and oxyhalides of trivalent bismu* Inaug. Diss., Stockholm, 1940, 140 pp., 42 figs.

A detailed account of work on the polymorphous forms of Bi_2O_3, on oxide ph with defective oxygen lattice, and the bismuth oxyhalides including sin double, triple, and mixed halogen layers. The work as a whole illustrates the u of X-ray methods in finding and exploring series of compounds new to inorgan chemistry. [M.A. 7–234, 491; 8–9, 215, 216, 287, 365; 9–44.] F. A. B.

Sillén (Lars Gunnar). *Über eine Familie von Oxyhalogeniden.* Naturwiss., 19 vol. 30, pp. 318–324, 10 figs.

A résumé of the crystal-structure types of the oxyhalides with a table formulae and cell dimensions. Some of them, like the sodium tungsten bronze can be regarded only as homogeneous phases, not compounds of constant com position. F. A. B.

Byström (Anders). *X-ray studies on orthorhombic PbO.* Arkiv Kemi, Min. Geo 1944, vol. 17B, no. 8, 6 pp., 2 figs.

The yellow orthorhombic form of PbO has unit-cell dimensions a 5·48, b 4·7 c 5·88Å., and contents 4PbO. A structure based upon the space-group $C_{2v}^5 = P$ has been derived consisting of double layers of lead atoms in the direction of t c-axis, interspaced by puckered layers of oxygen atoms. The bonding betwee adjacent lead layers is metallic. Prismatic needles of a hydrate formed at 270° are orthorhombic with unit-cell dimensions a 14·08, b 5·71, c 8·70Å. and probabl space-group $D_{2h}^{11} = Pbcm$ or $C_{2v}^5 = Pca$. Two additional hydrates (one crystallizi as needles) have also been synthesized. F. A. B.

Surugue (Jean) & Te-Tchao (Ouang). *Sur la diffraction des rayons X par quartz en oscillation ultrasonore.* Compt. Rend. Acad. Sci. Paris, 1943, v 217, pp. 177–179.

The intensity of Laue spots is increased proportionally to the amplitude of t vibrations. L. J. S.

Sillén (Lars Gunnar) & Sundvall (Herman). *Double molybdates and tungstat of alkali metals with lanthanum or bismuth.* Arkiv Kemi, Min. Geol., 194 vol. 17A, no. 10, 18 pp., 4 figs.

Fusing lanthanum molybdate with sodium chloride and potassium chloride i turn produced scheelite-like crystals with different lattice dimensions suggestin

iat interaction had occurred. A series of molybdates and tungstates was made this way all of which were found to contain alkali atoms. Cell dimensions of iese compounds with scheelite structure (none of which have vacant lattice ints) are:

	a.	*c*.		*a*.	*c*.
$La(MoO_4)_2$ ...	5·307	11·670Å.	$KBi(MoO_4)_2$ ...	5·380	11·916Å.
$\alpha La(MoO_4)_2$ ...	5·328	11·699	$NaCe(WO_4)_2$ ...	5·319	11·591
$\beta La(MoO_4)_2$ ...	5·420	12·114	$KCe(WO_4)_2$ ...	5·386	11·939
$La(WO_4)_2$ ...	5·335	11·629	$La_2(MoO_4)_3$? ...	5·35	11·85
$\alpha La(WO_4)_2$ ...	5·345	11·632	$Na_5La(WO_4)_4$ ...	11·600	11·546
$\beta La(WO_4)_2$ ...	5·443	12·034	$Na_5Bi(MoO_4)_4$ ...	11·444	11·520
$Bi(MoO_4)_3$ ...	5·232	11·495	$Na_5Bi(WO_4)_4$ ...	11·520	11·402
$\alpha Bi(MoO_4)_2$ ...	5·267	11·552			

ie three last compounds are closely related to the scheelite structure and para-eters have been calculated for the structure of $Na_5La(WO_4)_4$ based upon the ace-group $C_{4h}^6 = I4_1/a$. Every fifth WO_4 group in the scheelite structure is re-aced by a sodium atom. Orientated overgrowths of an $AM(XO_4)_2$ compound th one of the $A_5M(XO_4)_4$ type are readily formed. F. A. B.

LLÉN (Lars Gunnar) & LUNDBORG (Karin). *La_2MoO_6, ein Lanthanoxymolybdat mit Schichtenstruktur*. Zeits. Anorg. Chem., 1943, vol. 252, pp. 2–8, 3 figs.

Melts of lanthanum molybdate with NaCl, NaBr, or KNO_3 contain not only an kali compound of the scheelite type [preceding abstract], but also tetragonal ites, sp.gr. 5·52, which have unit-cell dimensions *a* 4·089, *c* 15·99Å., and con-nts $2La_2MoO_6$. A Patterson-Harker analysis yields a layer-type crystal-struc-re based upon the space-group $D_{2d}^{11} = I\bar{4}2m$ which is made up of La_2O_2 and O_4 layers. The structure is analogous to those of the Me_2O_2X type, where the logen atom X is replaced by the MoO_4 group. The author discusses the nature the atomic binding in the Me_2O_2 layers of these structures and concludes that least in the lanthanum compound the bond is not necessarily covalent.

F. A. B.

LLÉN (Lars Gunnar) & LUNDBORG (Karin). *X-ray studies on the systems Bi_2O_3–WO_3, Bi_2O_3–MoO_3, PbO–WO_3, and PbO–MoO_3*. Arkiv Kemi, Min. Geol., 1943, vol. 17A, no. 21, 11 pp., 1 fig.

Powder photographs of fusions of Bi_2O_3 and WO_3 in various proportions re-aled seven phases: (1) α-Bi_2O_3; (2) $Bi_{3\cdot8}W_{0\cdot2}O_{6\cdot3}$, sp.gr. 8·75, tetragonal, *a* 5·488, ·768Å.; (3) $Bi_{3\cdot42}W_{0\cdot58}O_{6\cdot87}$, sp.gr. 8·89, cubic, *a* 5·572Å.; (4) $Bi_{3\cdot33}W_{0\cdot67}O_7$, gr. 8·97, cubic, *a* 5·536Å.; (5) $Bi_{2\cdot4}W_{1\cdot6}O_{8\cdot4}$, sp.gr. 9·54, monoclinic, $a = b$ 7·674, $6{\cdot}39_8$Å., β 90°; (6) $Bi_{1\cdot6}W_{2\cdot4}O_{9\cdot6}$ monoclinic, probably identical with Zambonini's en preparation (1920); (7) pure WO_3. The metal atoms in phases 2–5 are as β-Bi_2O_3 placed on a face-centred cubic or pseudo-cubic lattice of cell edge ut 5·5Å. With the exception of phase 4 additional weak lines are present on powder photographs of phases 2–5 indicating that the real cell dimensions larger and the symmetry lower. By slowly cooling a melt of composition responding to phase 5 flat needles were obtained with monoclinic symmetry l cell dimensions $a = b$ 7·674, *c* $16{\cdot}39_8$Å., β 90°, probable space-group $= C2/m$. The authors consider that russellite [Min. Mag. 25–41] 'may be a

mixture of phases 4 (3) and 5 or of one of these phases with a material giv rather weak or broad powder photograph lines'. The systems Bi_2O_3–MoO_3 v also investigated and yielded seven phases: (1) α-Bi_2O_3; (2) probably isomorph with phase 2 in the Bi_2O_3–WO_3 system with tetragonal cell dimensions a 5·4 c 5·752Å.; (3) probably isomorphous with phase 3 or 4 in the Bi_2O_3–WO_3 syst cubic, a 5·635Å.; (4) and (5) two phases yielding complex powder photogra (6) probably $Bi_2(MoO_4)_3$; (7) pure MoO_3. An X-ray investigation of the syst PbO–WO_3 and PbO–MoO_3 has revealed only the compounds already kn Pb_2XO_5 and $PbXO_4$. Pb_2MoO_5 can be prepared as needles with needle axis 16·4

F. A. B

STÅHL (Sven). *The crystal structure of $ZnSb_2O_4$ and isomorphous compoun* Arkiv Kemi, Min. Geol., 1943, vol. 17B, no. 5, 7 pp., 2 figs.

Unit-cell dimensions have been determined from powder photographs of 1 following tetragonal isomorphous compounds:

	a.	c.		a.	c.
$MgSb_2O_4$... ...	8·445	5·907Å.	$NiSb_2O_4$... ...	8·35	5·91Å.
$MnSb_2O_4$... ...	8·685	5·980	$ZnSb_2O_4$ ...	8·491	5·920
$FeSb_2O_4$	8·592	5·905	$NiAs_2O_4$ ...	8·22	5·62
$CoSb_2O_4$	8·49	5·91			

Zinc antimonite, sp.gr. 5·64, has $4ZnSb_2O_4$ per unit cell, and a crystal-structure lated to that of Pb_3O_4 has been derived based upon the space-group $D_{4h}^{13} = P4/m$ in which ZnO_6 octahedra linked by opposite edges produce continuous strin parallel to the c-axis, linked laterally by antimony atoms. F. A. B

BRANDT (Karin). *X-ray studies on ABO_4 compounds of rutile type and AB_2 compounds of columbite type.* Arkiv Kemi, Min. Geol., 1943, vol. 17A, no. 8 pp.

Cell dimensions are given of the following artificial compounds which poss the crystal-structure of rutile:

	a.	c.		a.	c.
$CrTaO_4$	4·626	3·009Å.	$AlSbO_4$	4·510	2·961Å.
$FeTaO_4$	4·672	3·042	$CrSbO_4$	4·577	3·042
$RhTaO_4$	4·684	3·020	$FeSbO_4$	4·623	3·011
$CrNbO_4$	4·635	3·005	$RhSbO_4$... ...	4·601	3·100
$FeNbO_4$	4·68	3·05	$GaSbO_4$... ...	4·59	3·03
$RhNbO_4$... ...	4·686	3·014	$RhVO_4$	4·607	2·923

$FeVO_4$, however, yields a much more complicated pattern than those abo $AlVO_4$ is perhaps isomorphous with $MgMoO_4$ and $CrVO_4$ has been shown possess a new type of crystal-structure. Cell dimensions of artificial compoun isomorphous with columbite are:

	a.	b.	c.		a.	b.	c.
$MgNb_2O_6$ ...	5·017	14·18	5·665Å.	$MnNb_2O_6$	5·081	14·39	5·766Å.
$NiNb_2O_6$ ...	5·013	14·01	5·661	$ZnTa_2O_6$ ...	5·058	14·08	5·682
$CoNb_2O_6$ ...	5·036	14·12	5·701	$MnTa_2O_6$...	5·106	14·18	5·736
$FeNb_2O_6$ ...	4·992	13·96	5·616	$MnSb_2O_6$...	5·082	14·24	5·730
$ZnNb_2O_6$ ...	5·036	14·18	5·715				

A tin-bearing manganese tantalate mineral from Varuträsk, Sweden, has ›en shown to be a mixture of columbite and cassiterite [M.A. **8**–354].

F. A. B.

YSTRÖM (Anders). *The structure of natrophilite, $NaMnPO_4$.* Arkiv Kemi, Min. Geol., 1943, vol. 17B, no. 4, 4 pp.

Powder and Weissenberg photographs of a splinter of natrophilite yield unit-ll dimensions *a* 10·52, *b* 6·32, *c* 4·97 Å., cell contents $4NaMnPO_4$ and space-group $D_{2h}^{16} = Pnma$. The structure is of the olivine type with a statistical distribution the Mn and Na atoms over the two fourfold positions 4*a* and 4*c*. F. A. B.

ÁRBLAN (F.), BRANDENBERGER (E.), & NIGGLI (P.). *Geregelte und ungeregelte Strukturen von Titanaten und Ferriten und geregelte Umwandlungen der TiO_2-Modifikationen.* Helvetica Chimica Acta, 1944, vol. 27, pp. 88–96, 6 figs.

Disordered cubic $Li_2Fe_2O_4$ (*a* 4·15 Å.), Li_2FeO_3, and Li_2TiO_3 have the FeO(NaCl) ructure with some of the metal atom positions empty; $Li_2Fe_{10}O_{16}$ (*a* 4·16 Å.) s the magnetite structure with some of the FeO positions unoccupied. $Li_2Fe_2O_4$ mpered at 570° gives a tetragonal form (*a* 4·05, *c* 4·37 Å.) related to anatase. ookite, but not anatase, can be transformed to rutile, the (100) planes of both ing parallel and the *c*-axis of rutile parallel to the zone-axes [001], [010], [027], [023] of brookite. [M.A. **5**–313, **6**–332, **7**–493.] L. J. S.

ÁRAY–SZABÓ (St. v.). *Der Strukturtyp des Perowskits ($CaTiO_3$).* Naturwiss., 1943, vol. 31, pp. 202–203, 2 figs.

DLITZ (Otto). *Ditto.* Ibid., 1943, vol. 31, p. 369.

Oscillation photographs of a perovskite crystal from Slatoust, Urals, yield a eudo-cubic unit-cell with all three edges approximately equal to 7·60 Å., β proximately 90°, and monoclinic space-group $C_{2h}^2 = P2_1/m$. The unit cell con-ining $8CaTiO_3$ is built up from deformed TiO_6 octahedra. Diagrams of the wly described structure and of that formerly accepted are given. Artificial mpounds $BaTiO_3$, *a* 3·98 Å., $BaSnO_3$, *a* 4·10 Å., and $BaZrO_3$, *a* 4·19 Å. are found have the simpler cubic structure, whereas $PbZrO_3$, *a* 9·28 Å., and $CaSnO_3$, ·80 Å., possess the new perovskite structure. [M.A. **7**–398.] F. A. B.

ANDT (Karin). *X-ray analysis of $CrVO_4$ and isomorphous compounds.* Arkiv Kemi, Min. Geol., 1943, vol. 17A, no. 6, 13 pp., 4 figs.

Dark-brown crystals of chromium vanadate, sp.gr. 3·89, orthorhombic, *a* 5·568, 8·208, *c* 5·977 Å., unit-cell contents $4CrVO_4$, space-group $D_{2h}^{17} = Cmcm$. The ystal-structure consists of linked CrO_6 octahedra and VO_4 tetrahedra, and is a w ABX_4 structure type to which the following compounds also belong:

	a.	*b.*	*c.*
CrO_4 ...	5·492	8·219	6·113 Å.
CrO_4 ...	5·505	8·281	6·207
CrO_4 ..	5·426	8·925	5·878

	a.	*b.*	*c.*
$ZnCrO_4$ ...	5·505	8·383	6·219 Å.
$CdCrO_4$ ...	5·674	8·674	6·893

F. A. B.

Strunz (H.). *Die Struktur von Rhodizit.* Naturwiss., 1943, vol. 31, p. 68, 1 fig.

The unit cell, a 7·30Å., contains $KNaLi_4Al_4B_{10}Be_3O_{27}$; space-group $T_d^1 = P\bar{4}3$. L. J. S.

Hendricks (Sterling B.). *Polymer chemistry of silicates, borates, and phosphates.* Journ. Washington Acad. Sci., 1944, vol. 34, pp. 241–251, 6 figs.

From a consideration of the way in which SiO_4 tetrahedra combine to form chain, band, sheet, and network polymers, probable types of pattern elements and group structures for borates and phosphates are described in outline and figured. In an appendix, X-ray data, &c., by H. F. McMurdie are given for hexagonal B_2O_3, sp.gr. 2·460, indices ω 1·648, ϵ 1·615, a 4·33, c 8·392Å., unit-cell contents $3B_2O_3$. F. A. B.

Goldschmidt (H. J.) & Rait (J. R.). *Silicates of the perovskite type of structure.* Nature, London, 1943, vol. 152, p. 356.

Merwinite, $Ca_3MgSi_2O_8$, a common constituent of many types of slag, possesses a perovskite type of structure, with pseudo-cell edge 3·76Å. Manganese-merwinite, $Ca_3MnSi_2O_8$, with smaller cell dimensions can also be made by firing 80% β-Ca_2SiO_4 and 20 % Mn_2SiO_4 at 1300° C. The existence of the two compounds emphasizes the tolerance of the perovskite structure type. F. A. B.

Náray-Szabó (St. v.). *Die Strukturen von Verbindungen ABO_3. „Schwestern strukturen".* Naturwiss., 1943, vol. 31, p. 466.

Perovskite, $CaTiO_3$, is monoclinic and pseudo-cubic [M.A. **9**–101]. PbTiO$_3$ is tetragonal with a 3·89, c 4·13Å., the unit cell containing one molecule; space-group $D_{4h}^1 = P4/mm$. $NaWO_3$ [M.A. **5**–184] and ReO_3 (a 3·734Å.) are cubic; WO_3 (with W^{6+} and W^{5+}; a 7·28, b 7·48, c 3·82Å.) and $NaIO_3$ are of the orthorhombic type, and ScF_3 (a 4·022, α 89° 34½′) of the rhombohedral type. These similar and slightly distorted structures are called 'sister structures'. L. J. S.

Gruner (John W.). *The structure of stilpnomelane reexamined.* Amer. Min., 1944, vol. 29, pp. 291–298, 2 figs.

Revised X-ray data [M.A. **7**–93] are given for stilpnomelane a 5·39, b 9·4, $c \sin\beta$ 12·12Å.; cell contents $(OH)_4(K,Na,Ca)_{0-1}(Fe,Mg,Al)_{7-8}Si_8O_{23-24}.2\text{–}4H_2O$. The structure is based upon that of talc and contains channels parallel to the a-axis in which K ions replaceable by Tl may be situated. Fankuchen's superlattice [Min. Mag. **25**–201] is related to the above dimensions in a way recalling Hendricks's observations [M.A. **7**–496] on the polymorphism of the micas. F. A. B.

Fankuchen (I.) & Schneider (M.). *Low angle X-ray scattering from chrysotile.* Journ. Amer. Chem. Soc., 1944, vol. 66, pp. 500–501.

Two lines in the low-angle diagram have spacings in the ratio $\sqrt{3}$. Assuming hexagonal packing, the diameter of the fibrils is calculated as 195–218Å. for different grades of chrysotile-asbestos. L. J. S.

ANKEL (J. J.). *On silicates and dusts from the Witwatersrand gold mines.* (Some preliminary notes.) Journ. Chem. Metall. Mining Soc. South Africa, 1944, vol. 44, pp. 169–177, 6 figs.

Three chemical analyses are given of specimens of sericite from the banket owing them to be of muscovite type. X-ray powder photographs confirmed is conclusion showing only small differences in unit-cell dimensions from one other. Pyrophyllite, whose identification has also been confirmed by X-ray notographs, occurs in association with quartz veins from nearly all reef mines d is found massive, as veins in shales, as needles, flakes, and rosettes, and eudomorphous after kyanite and after the felspar and pyroxene of a dolerite. emical analyses are also given of a bottle-green chlorite, actinolite, clinozoisite, loritoid, and dickite (identity confirmed by X-ray methods by R. E. Grim). The -ray powder method has also been applied to quantitative work on the mine sts. Preliminary investigations show that the percentage of quartz in dusts m the Witwatersrand is rarely less than 85 %, the remainder being muscovite.

F. A. B.

COCK (T. C.), CLARK (L. M.), & THURSTON (E. F.). *The scaling of boilers. Part V. Identification of some of the combinations of silica and of magnesia in boiler scales.* Journ. Soc. Chem. Ind., 1944, vol. 63, pp. 292–298.

X-ray and optical methods have been used to identify the following constituents boiler and pipe-line scales: crestmoreite, sulphatic cancrinite, periclase, baryte, rysotile, sepiolite, sodalite, analcime, brucite, and a new compound magnesium droxyphosphate $Mg_3(PO_4)_2.Mg(OH)_2$ refractive indices $\alpha = \beta$ 1·533, γ 1·552 parallel to the needle axis). Powder data are tabulated and compared with those mineral specimens. Not all the above minerals are primary constituents of the iler scales; periclase, sodalite, analcime, and sulphatic cancrinite being of secon- ry origin. Reasons are given for the probability of the existence of amorphous addition to crystalline components in these scales. Chemical, optical, and X-ray ta are also determined for many magnesium phosphates previously described the literature. One of them $Mg_3(PO_4)_2.4$–$5H_2O$ is identical with the product tained by heating newberyite for a long time with successive amounts of water 70° C. [M.A. **8**–116.]

F. A. B.

Miscellaneous

ATYNSKY (V. M.)]. Ратынский (В. М.). Накопление германия в углях. Доклады Акад. Наук СССР, 1943, vol. 40, pp. 223–227.

TYNSKY (V. M.). *Accumulation of germanium in coals.* Compt. Rend. (Doklady) Acad. Sci. URSS, 1943, vol. 40, pp. 198–200.

About 500 samples of coals were examined. Those from the Urals showed low content (as low as 0·001 % in the ash), while those from the Caucasus are her (up to 1 % in the ash). Ash-poor coals with much clarain-vitrain are the hest. [V. M. Goldschmidt, M.A. **7**–165; **9**–35.]

L. J. S.

KURBATOV (S. M.) & IVANOV (A. S.) Курбатов (С. М.) и Иванов (А.С.). Везувиа из месторождения близ озера Чертаныш на Южном Урале. —*The vesuvian from the locality of the lake Tchertanych in the south Ural.* Труды Ленингра Общ. Ест., Отд. Геол. Мин. (Trav. Soc. Nat. Leningrad, Sect. Géol. Mi 1937, vol. 66, no. 1, pp. 89–107 (Russian), p. 108 (English summary), 1 p 5 text-figs.

Small, pale green, prismatic crystals of idocrase occur in crevices in a garn idocrase-chlorite-rock resulting from the metamorphism of pyroxenite and se pentinite near a granite contact. The frequencies of 23 crystal-forms are not and light-figures are represented on projections; $a:c = 1:0{\cdot}537475$; n_p 1·72 n_g 1·730. L. J. S.

MIROPOLSKY (L. M.) & BOROVICK (S. A.). *Spectrum analysis data on calciu iron-copper bearing minerals and native sulphur from Tartary.* Compt. Re (Doklady) Acad. Sci. URSS, 1943, vol. 39, pp. 365–368.

Few elements were found in the native sulphur, but up to 18 in calcite, pyri vivianite, and various copper minerals. L. J. S.

BROWNELL (G. M.). *Quartz concretions in gypsum and anhydrite.* Univ. Toron Studies, Geol. Ser., 1942, no. 47, pp. 7–18, 6 figs.

A commercial deposit of gypsum with associated anhydrite and limeston near Amaranth, 40 miles north of portage La Prairie, on the west side of La Manitoba, contains concretions of quartz and chalcedony with radiating a concentric structures rarely reaching 18 inches in diameter. These appear to ha been deposited from solutions with the anhydrite and the limestone, before t hydration to gypsum took place. M. A. P.

WHITE (Charles Henry). *Why the sea is salt.* Amer. Journ. Sci., 1942, vol. 24 pp. 714–724.

The widely differing amounts of sodium and chlorine in igneous rocks is again the view that the water of the oceans was originally fresh and that the salt h been derived from the rocks. It is suggested that the free elements in a gaseo mass would be layered according to their density, and compounds with the great heat of formation would be first formed. Thus volatile alkali chlorides with low melting-point would form a crust on the primeval silicate crust and wou be taken up by the first rains. L. J. S.

LACROIX (A.). *Nouvelles observations sur les fulgurites du Sahara.* Bull. Servi des Mines, Afrique Occidentale Française, Dakar, 1942, no. 6, pp. 23–48, 7 p

Fulgurites collected by Fernand Jacquet[1] in the sand dunes of Mauritania a described. It has been found that the fulgurites occur in hollows and on t lower parts of dunes, and that they occur on moving dunes as well as on fixed on Forms are described with 'wings' and coral-like growths. One tube was excavat to a depth of 1 metre without reaching its base. The mechanism of formation discussed. Brief mention is made of pseudo-fulgurites, calcareous and ferr ginous tubes formed round plant roots. [M.A. **1**–148, **5**–78.] W. C. S.

[1] Fernand Jacquet (1903–37), geologist, French West Africa. Memoir by M. Gignou with portrait and bibliography, ibid., pp. 11–20.

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